Online ISSN : 2249-4626
Print ISSN : 0975-5896

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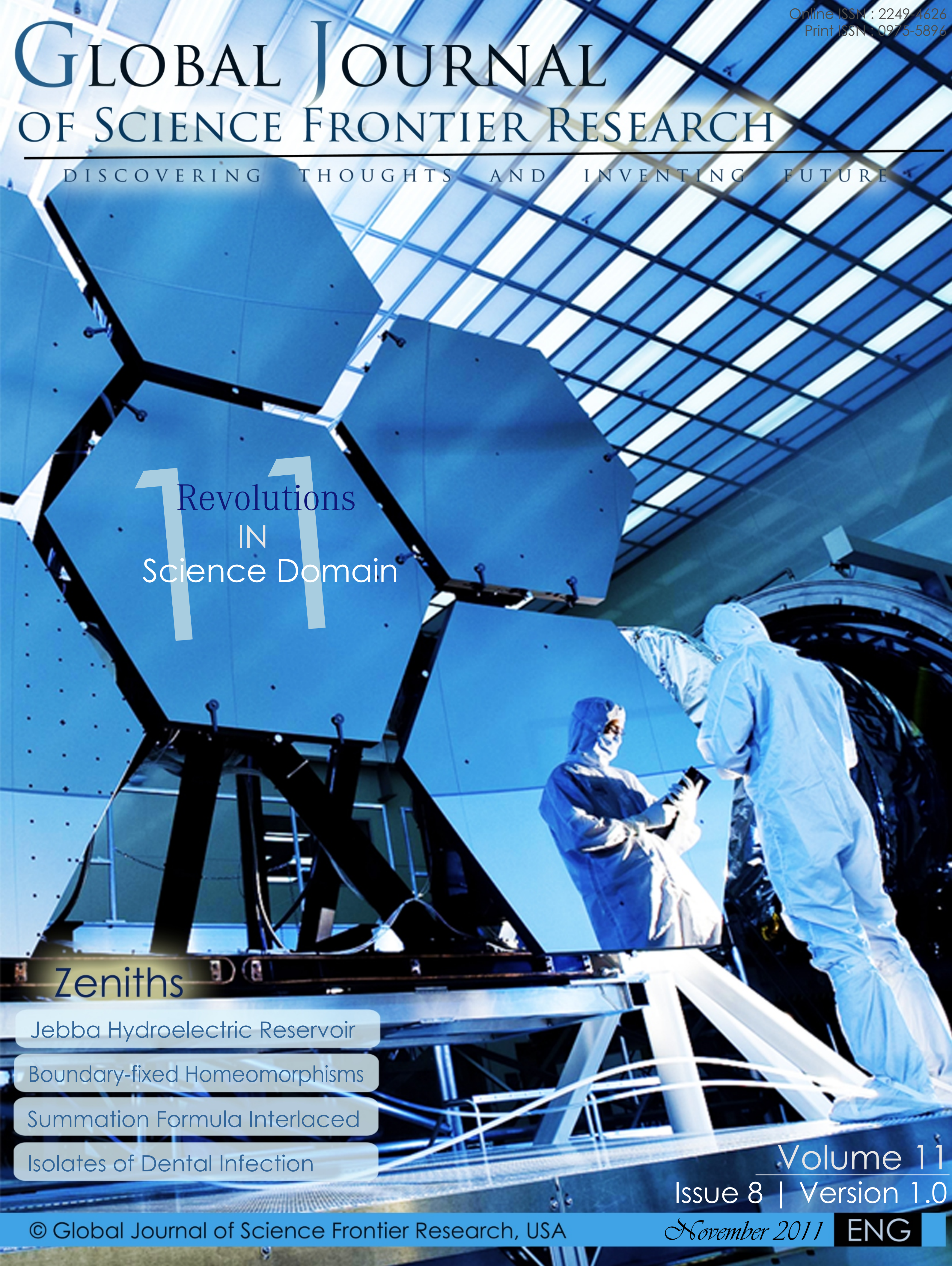

11

Revolutions
IN
Science Domain

Zeniths

- Jebba Hydroelectric Reservoir
- Boundary-fixed Homeomorphisms
- Summation Formula Interlaced
- Isolates of Dental Infection

Volume 11
Issue 8 | Version 1.0
November 2011 ENG

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Global Journal of Science Frontier Research

Volume 11 Issue 8 (Ver. 1.0)

Open Association of Research Society

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Contents of the Volume

Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & Print ISSN : 0975-5896

Relationship between Power Generation and Reservoir Elements in the Jebba Hydroelectric Reservoir, Nigeria

By Ifabiyi, I.P.
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Abstract - Electricity came to Nigeria (in 1896)15 years after it got to England. Despite its long history in Nigeria, electricitygeneration is still at its low ebb with power outages being the order of the day.Power generation is a product of reservoir operation;hence, the understanding of the interactions between them iscrucial to energy supply. This study examines the interactions between electricity generation and reservoir elements in Jebba dam, Nigeria. Monthly data were collected on 11 reservoir elements and on monthly electricity generation from (1989-1999). Factor-multiple regression and factor-stepwise regression methods were adopted in the interpretation of the relationships between power generation and reservoir elements. A total of 12 factor analytical procedures were carried out, this representone operation per month. This allowed the exhibition of the relationships on monthly basis. The factor analysis reduced the monthly variables to between 3 to 4 orthogonal factors. All the factors were important to the explanation of the variance with the percentages of explanations ranging between 79 and 92%. The result of the regression analyses showed that reservoir elements were strong predictors of power generation in all the months with the exception of April. The percentage explanation for factor multiple regression range from 13 to 98%; while that of factor stepwise regression ranges from 57.8% to 95.7% , with the exception of April when all the variables entered the equation. Twenty one reduce - rank (eqs. 5-26)power generation models were developed for predicting power generation in Jebba.

Keywords : *electricity, reservoir elements, factor-regression, inflow, reservoir level.*

GJSFR-D Classification : *FOR Code: 090607, 091305, 09069*

RELATIONSHIP BETWEENPOWER GENERATION AND RESERVOIRELEMENTS IN THE JEBBA HYDROELECTRIC RESERVOIR, NIGERIA

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Ifabiyi, I.P.

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Keywords : electricity, reservoir elements, factor-regression, inflow, reservoir level.

I. Introduction

Electricity in Nigeria dated to 1896 when it was first generated in Lagos 15 years after it was introduced to England. By 1928 the NESCO started operation in Jos, in 1951 ECN was inaugurated and this later transformed into National Electricity Power Agency in 1972. Despite its early arrival electricity has a slow pace of development in Nigeria. For over 20 years before 1999, the Nigerian power sector did not witness any substantial investment. This brought power to a deplorable condition. For example, in 2001 generation went down from the installed capacity of 5,600 mw to an average of about 1,750 mw compared to a load demand of 6,000mw across the country. Only 19 out of the 79 installed generating units were in operation (Sambo, 2008). Hence, electricity generation, distribution and transmissionhave been a serious problem in Nigeria. The demand for electricity in the country far outstrips the supply.

The problem with Nigeria power sector ranges from corruption, negligence, climate change, political restiveness, inefficient water management scheme among others. Water management in power generation is very crucial to power generation. Inefficient planning can bring about unutilized water; a condition which apart from causing low power generation can also endanger the dam and loss of enormous water in the reservoir to evaporation.

Efficient water management can only be realized when a sufficient understanding of the complex interactions between reservoir elements and electricity generation is understood (Sharma, 1995; Patra, 2001; Panigraphi; 2008). Causal relationships exist between hydroelectricity and reservoir elements. For example the reservoir inflows which comprises of peak inflow, average inflow and minimum inflow largely determine the amount of water that enters into the reservoir. The inflowsin turnscontrol the amount of water that determines the reservoir level, the pressurehead and the reservoirstorage balance. The outflows comprising of peak outflow, minimum outflow and average outflow are crucial to reservoir balance, the reservoir useful life, the reservoir discharge and the aquatic ecosystem in the downstream area. It will affect the rate of inundation of flooding, water scarcity, erosion, siltation, flood plain contraction, and fishery. And also control domestic and agricultural water supply in the downstream area. Reservoir evaporation and important reservoir element is a signal to how efficient water is used. Reservoir evaporation willalso impact on water availability in the reservoir.

This present study will investigate the relationships between reservoir elements and electricity generation in Jebba dam reservoir with a view to predicting monthly power generation in the hydropower station.

II. The Study Area

Jebba reservoir is located on latitude 9° 35` and 9° 50`N and longitude 4° 30` and 5° 00` E. It located on

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river Niger, Nigeria (Fig. 1). It is a 540mw dam. Jebba is underlain by Basement

Fig.1 : The Niger Basin

(*Adapted fromEmoabino, I. U., Alayande, A. W. and O. A. Bamgboye (2007)*)

Complex rocks such as porphyritic granite, mica, quartzite, etc (Sagar, 1985; NEDECO, 1959; Imevbore, 1970). It has an estimated surface area of 303km^2 and a volume of 3.31x 10^{9}m^3. The maximum depth is 105m and a mean depth f 11m (Ita, et al 1984).

According to NEDECO (1959) and NEDECO and Balfour Beatty (1961) 2 patterns are discernable in the seasonal hydrological regime of river Niger in Jebba. In the months of May to October rainfall in the northernparts of Nigeria south of Niamey produces flood that quickly reaches Jebba area witha peak of 4,000-6,000 m^3 s^{-1} in September to October (Figs 2,a,b,c). This flood water is laden with silt and clay sediment and its of high turbidity. Due to its colour, it is locally called 'white flood'. The second flood originates from the rivers headwater region from rivers of high

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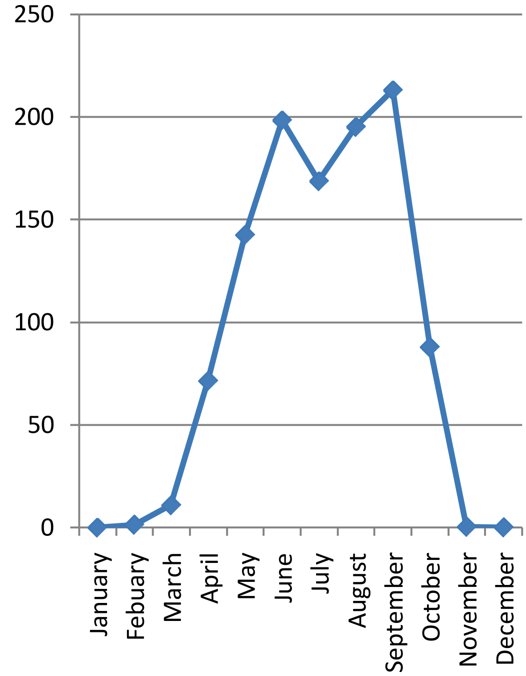

Fig 2(a) : Pattern of monthly rainfall in Jebba

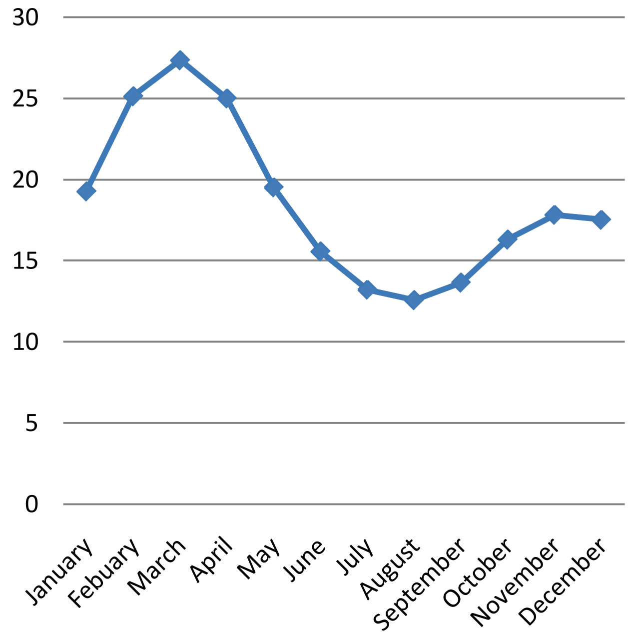

Fig.2 (c): pattern of monthly evaporation in Jebba.

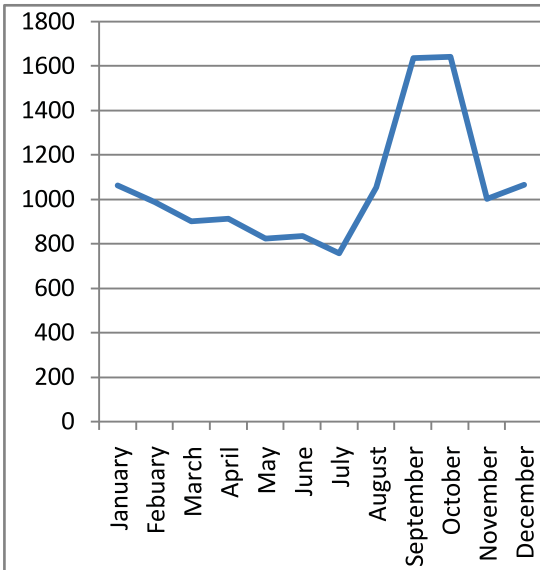

Fig. 2(b) : pattern of Monthly inflow in Jebba

Fig. 2(a., b., c.) : Monthly patterns of Hydrometeorological variables in Jebba.

annual rainfall in the Fouta Djallon highlands in Guinea and passes through sub-arid region and deltaic swamps in Timbuktu. In this area much of the silt is lost to evaporation and infiltration. Little water is added before it reaches Kanji in November with a peak flow of 2000 $m^3 s^{-1}$, the water is relatively clear known as black flood (Oyebande, et al, 1990; Mbagwu, et al, 2000;; Olaosebikan, et. al., 2006). These floods lead to high water levels which always give rise to water release at the dam sites which eventually have negative consequences on the study area. The flow regime of the River Niger below the Jebba dam is governed by the operations of the Kanji and Jebba Hydroelectric schemes and runoff from the catchments. The annual 'white floods' event which usually sets in July and peaks in September does not maintain the same frequency as almost every four years the flood sets in with greater velocity, this lead to the dam overflowing its banks. This caused destruction of sugar cane plantation by inundation of sugar cane field, irrigation pumps and submerging of farming areas occupied by the villages.

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According to Lawal and Nagya (1999), Bolaji (1999), Olukanni and Salami (2008) and Sule, et. al. (2009) the havoc wreaked by the flooding of the lower Niger in 1998 and 1999 also has its effect on social services to the people of the area. For example schools in about 32 and 52 villages were submerged in the flood of 1988 and 1999 in the downstream of Jebba respectively, while schooling for fleeing villagers remain disrupted and the hospitals were not spared by flood.

III. Materials and Methods

The data required in this study are mainly data on the monthly electricity generation in the power dam and information on the reservoir elements. These data were collected from the Hydrology Department of Power Holding Company, Jebba Hydropower Dam. A total of 10 hydro engineering/ reservoir elements were studied on monthly basis in this study. These are minimum inflow, storage balance, evaporation, average outflow, peak inflow, peak outflow, reservoir level, average inflow, minimum evaporation outflow and discharge. These parameters were sampled for 10 years (1989-1999).

The data collected were subjected to both descriptive and inferential analyses. The descriptive methods used in this study are: mean , frequency analysis and graphs. The inferential methodis the factor-regression model, which is combination of factor analysis and multiple regression and stepwise regression methods.The factor regression model(West, 2002; Carvalho, 2008) or hybrid factor model (Meng, 2011) is a special multivariate model with the following form.

$$\mathbf{y}_n = \mathbf{A}\mathbf{x}_n + \mathbf{B}\mathbf{z}_n + \mathbf{c} + \mathbf{e}_n \quad \text{.....(eq.1)}$$

where,

$\mathbf{y}_n$ is the *n*-th $G \times 1$ (known) observation.

$\mathbf{x}_n$ is the *n*-th sample L_x (unknown) hidden factors.

$\mathbf{A}$ is the (unknown) loading matrix of the hidden factors.

$\mathbf{z}_n$ is the *n*-th sample L_z (known) design factors.

$\mathbf{B}$ is the (unknown) regression coefficients of the design factors.

$\mathbf{c}$ is a vector of (unknown) constant term or intercept.

$\mathbf{e}_n$ is a vector of (unknown) errors, often white Gaussian noise.

The factor regression model can be viewed as a combination of factor analysis model ($\mathbf{y}_n = \mathbf{A}\mathbf{x}_n + \mathbf{c} + \mathbf{e}_n$ ..... (eq2)) and regression model ($\mathbf{y}_n = \mathbf{B}\mathbf{z}_n + \mathbf{c} + \mathbf{e}_n$ ... (eq3)).

Alternatively, the model can be viewed as a special kind of factor model, the hybrid factor model

$$\mathbf{y}_n = \mathbf{A}\mathbf{x}_n + \mathbf{B}\mathbf{z}_n + \mathbf{c} + \mathbf{e}_n$$

$$= \begin{bmatrix}\mathbf{A} & \mathbf{B}\end{bmatrix}\begin{bmatrix}\mathbf{x}_n \\ \mathbf{z}_n\end{bmatrix} + \mathbf{c} + \mathbf{e}_n$$

$$= \mathbf{D}\mathbf{f}_n + \mathbf{c} + \mathbf{e}_n \quad \text{.......... (eq. 4)}$$

where, $\mathbf{D} = \begin{bmatrix}\mathbf{A} & \mathbf{B}\end{bmatrix}$ is the loading matrix of the hybrid factor model and $\mathbf{f}_n = \begin{bmatrix}\mathbf{x}_n \\ \mathbf{z}_n\end{bmatrix}$ are the factors, including the known factors and unknown factors.

Factor analysis was usedfor data reduction purposes: To get a small set of variables preferably uncorrelated from a large set of variables most of which are correlated to each other in the data set. Multiple regression in form of factor regression (where the orthogonal factor scores were used as input into the regression model) was used to study the relationships between reservoir elements and electricity generation. Stepwise regression analysis was used as a (reduce-rank model) to reduce and to model power generation in Jebba.

IV. Result and Discussion

The percentages of explanations and the factor defining variables of the monthly factor analysis equations are presented in Table 1.

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Table 1: Percentage Contribution and Cumulative Percentage Contribution of Monthly Factor Defining Variables of Monthly Reservoir Elements in Jebba

S/N	Month	Factors Defining Variables			Cumulative Contribution (%)
		Reservoir Elements		Percentage Contribution (%)	
1	January	1.	Peak Inflow	49.6	82.6
		2.	Storage Balance	20.0	
		3.	Evaporation	12.9	
2	February	1.	Minimum Inflow	33.6	90.7
		2.	Storage Balance	24.9	
		3.	Average Outflow	21.7	
		4.	Peak Inflow	10.3	
3	March	1.	Minimum Inflow	33.6	91.1
		2.	Storage Balance	25.0	
		3.	Average Outflow	21.7	
		4.	Peak Inflow	10.7	
4	April	1.	Peak Outflow	37.4	79.2
		2.	Storage balance	26.4	
		3.	Average Inflow	15.4	
5	May	1.	Peak Inflow	27.5	89.7
		2.	Reservoir Level	25.5	
		3.	Evaporation	11.2	
		4.	Average Outflow	25.4	
6	June	1.	Minimum inflow	24.9	88.8
		2.	Average Outflow	23.9	
		3.	Discharge	16.2	
		4.	Reservoir Level	23.7	
7	July	1.	discharge	37.4	88.0
		2.	storage balance	36.4	
		3.	minimum outflow	14.2	
8	August	1.	Average Outflow	37.4	88.0
		2.	Storage Balance	36.4	
		3.	Discharge	14.2	
9	September	1.	Minimum Inflow	33.0	87.4
		2.	Average Outflow	30.8	
		3.	Reservoir Level	23.6	
10	October	1.	Peak Inflow	38.4	84.3
		2.	Storage Balance	25.0	
		3.	Average Inflow	20.9	
11	November	1.	Average Inflow	27.9	80.9
		2.	Peak Inflow	27.4	
		3.	Discharge	25.4	
12	December	1.	Peak Outflow	26.0	92.3
		2.	Minimum Outflow	18.2	
		3.	Storage	17.4	
		4.	Discharge	15.8	
		5.	Evaporation	14.8	

(Source : Authors computation, 2011)

The factor defining variables displayed different patterns. The cumulative percentage explanations range from 79.2 to 92.3%. This shows that all the percentages of explanations were highthroughout the 12 months under study. All the reservoir elements provided strong explanations of the variance (Table 1and Fig. 2). The numbers of selected defining factors vary from onemonth to the other. For example, in the month of December, the 10 reservoir elements were reduced to 5 orthogonal factors with explanations on 92.3%. In 4 of the months (February, March, May and June) the 10 elements were reduced to four each with cumulative explanations ranging from 88% to 91%. In all other instances 3 factors were selected as relevant to the explanations (Table 1). The factor scores were used as input into the multiple regressions and stepwise multiple regression models.

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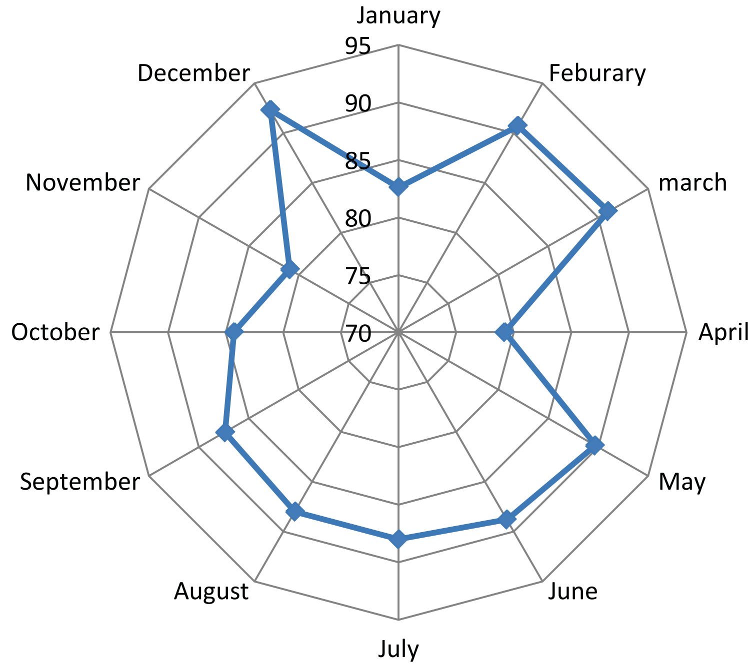

Fig.2 : Monthly Percentage Contribution Of Factor Analysis Cummulative Varaiance Explained By Reservoir Elements

According to Table 2 and Fig. 3 the percentages of explanations of the multiple regression range from 13.4% in April and 98.5% in February, while that of stepwise multiple regression method was a highest of 95.7% in February, while no value was recorded for April. In the case of multiple regression all the percentages of explanation were sufficiently strong with the exception of April, which has the least explanation of 13.4%. The month of April is generally a month of low flow in Jebba when the reservoir is generally at its lowest when it is expected that the reservoir elements will possibly contribute little to power generation.

Table 2 : Percentages of explanations of regression models

S/N	Month	Multiple Regression R^2	Stepwise Regression			Frequencies of entries of Individual Variables into the Regression Equation
			Cumm.% R^2 (%)	Reservoir Elements	R^2 of Individual Factors (%)	
1	January	59.3	57.8	Discharge	57.8	1
2	February	98.5	95.7	Peak Inflow	95.7	2
				Minimum Inflow	2.70	
3	March	95.3	87.3	Storage	69.8	2
				Average Outflow	17.5	
4	April	13.4	0.00	Nil	0.00	0
5	May	97.6	95.0	Reservoir Level	95.0	1
6	June	96.9	78.5	Reservoir Level	78.5	1
7	July	89.0	87.1	Discharge	87.1	1
8	August	89.1	87.5	Discharge	87.5	1
9	September	79.7	72.2.	Peak Inflow	72.2	1
10	October	85.8	84.4	Peak Inflow	84.4	1
11	November	54.0	52.0	Discharge	52.0	1
12	December	91.0	55.5	Evaporation	55.5	1

(Source : Authors computation, 2011)

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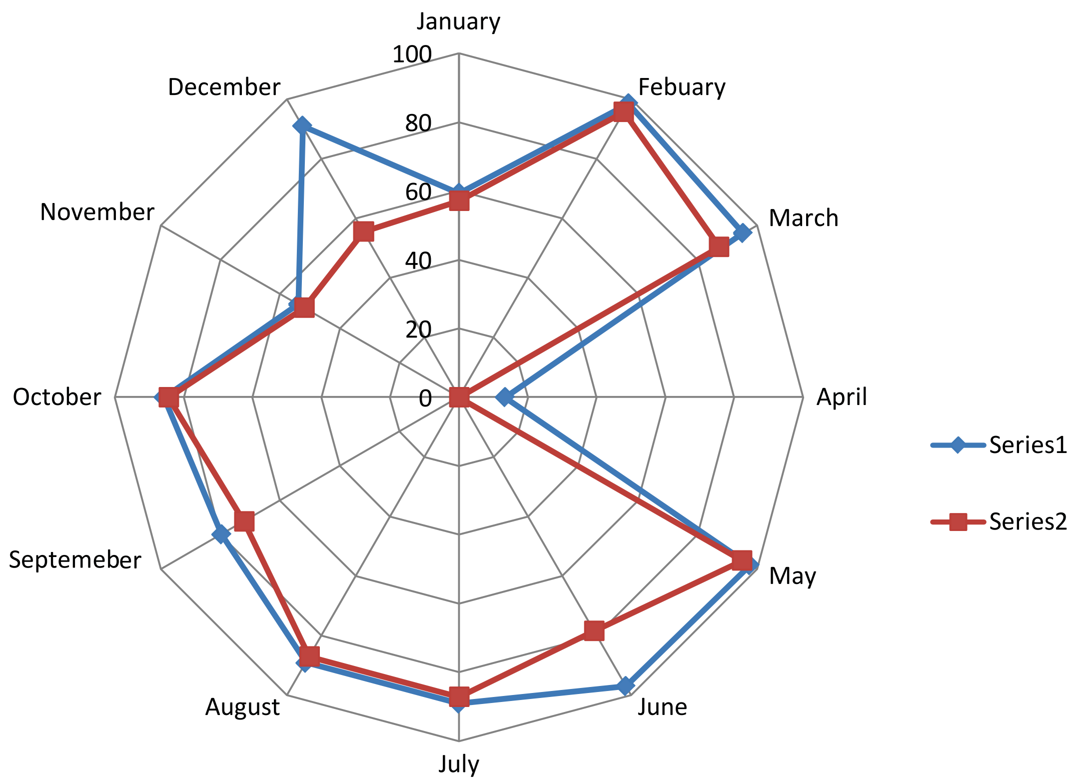

Fig. 3 : Pecentages of explaltions of multiple and stepwise regerssion in Jebba dam

***Note** : Series1=Multiple Regression; Series 2 =Stepwise Regression*

The result also showed that the entry of individual reservoir elements into the stepwise regression equation (Table 3; Fig.4)depicts that reservoir level has the highest frequency of 3 times, while minimum inflow, peak inflow and discharge entered the equation 2 times each, andstorage balance, lake evaporation and average outflowappeared once,while peak outflow, average outflow and minimum outflow made no appearances at all. The dominance of reservoir level suggestsits relevance to power output in the power house. The higher the reservoir level the higher the power generated. The relevancies of the inflow variables also show that it is the major source of water to the reservoir. The negligence of the outflow terms signify that reservoir balance was not really exceeded in such a waythat much water was available for spilling to the downstream. This agrees with the work of Aribisala and Sule (1999) and Salami, (2010) on the downward trend of water inflow in the power dams of Kainji and Jebba.

Table 3 : Frequency of Entries of Factor Defining Variable in the Stepwise Regression Equation.

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct.	Nov.	Dec	TOTAL
1.Mini Inflow	0	1	0	0	0	0	0	0	1	0	0	0	2
2.Storage Balance	0	0	1	0	0	0	0	0	0	0	0	0	1
3. Evaporation	0	0	0	0	0	0	0	0	0	0	0	1	1
4.Average Outflow	0	0	1	0	0	0	0	0	0	0	0	0	1
5.Peak Inflow	0	1	0	0	0	0	0	0	0	1	0	0	2
6.Peak Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Reservoir. Level	0	0	0	0	1	1	1	0	0	0	0	0	3
8. Average Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0
9.Minimum Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0
10. Discharge	1	0	0	0	0	0	0	1	0	0	1	0	2
TOTAL	1	2	2	0	1	1	1	1	1	1	1	1	

Global Journal of Science Frontier Research Volume XI Issue VIII Version I November 2011

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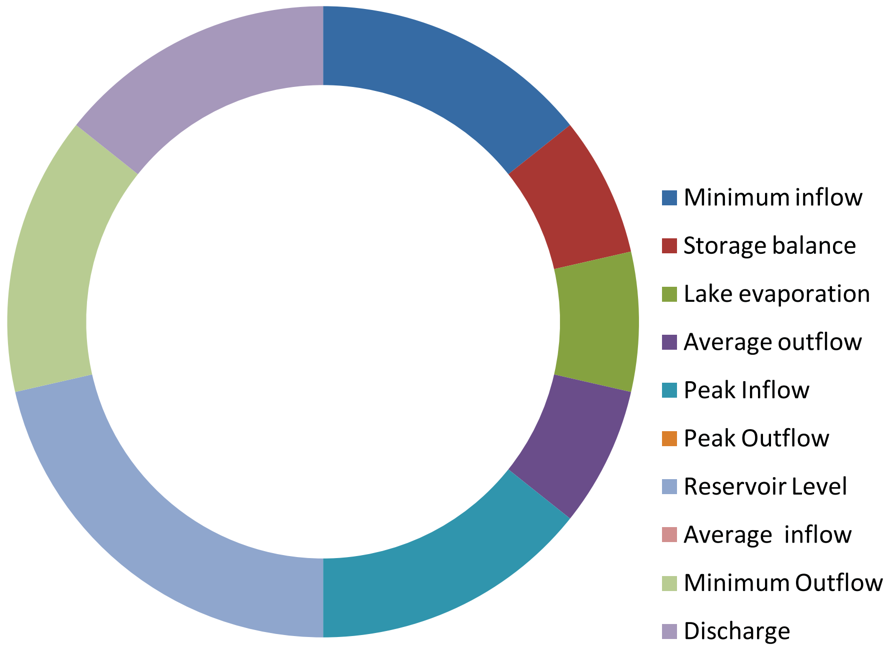
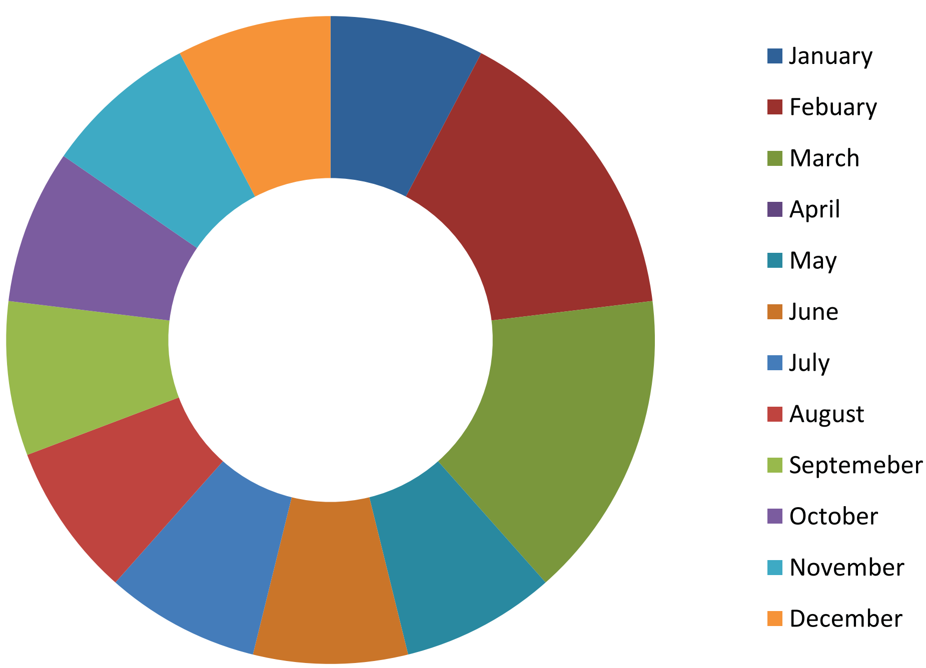


Fig.4 : Frequenecies of Entries of Individual reservoir elements into the stepwise regerssion equation

On the pattern of entries on monthly basis, only the months of February and March have 2 entries while all other with the exception of April had one variable each in the stepwise regression model. This clearly suggests that high level of redundancy exist in the nature of explanations of reservoir elements and power generation. This shows that some elements may sometimes not be needed in monthly power generation (Fig 5).

Fig. 5 : Frequencies of Monthly Entrires of percentages of explanations of stepwise regerssion model into the Stepwies regerssion model



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V. Relationships Between Electricity Generation and Reservoir Elements and Power Generation Models in Jebba Dam

The following models (eq. 5-26) are derived from the regression models and can be used to predict monthly electric power generated in the Jebba hydro power dam.

a) January

The result of the multiple regression showed that peak inflow, storage and evaporation explained 59.3% of the variance in the total electricity generated in January. This suggests that 40.7% of power generated in January is due to other factors. Mean in January the Jebba reservoir will be experiencing the black flood.

Y_1 Jan = 151,873.50 + 14,339.5pkinflow + 10,055storage + 14644evaporation ......(eq.5)

(R^2 = 59.3%;SE=23,155)

b) February

In February, the flood water is receding and the reservoir balance is dropping, inflow is getting reduced and little water output is allowed. Hence, minimum inflow, reservoir storage, average output and peak flow accounts for 98.5%. The stepwise analysis that was used as a rank-reduction model was showed that peak inflow and minimum inflow are the dominant factor respectively as these 2 elements explained 98.3%. Hence, prediction of electricity generation in February is better with equation 2.

Y_1Feb=149,508.44+7166.98mininflow+1,142.3storage+1,697.8avgoutput+433,446pkinflow) ..... (eq. 6)

(R^2=98.5%; SE=7,744)

Y_2Feb=149,508.44+43,445.9pkinflow+7,166.98mininflow ...... (eq.7)

(R^2 = 98.3%;SE=6750.7)

c) March

In march 4 factors namely: minimum inflow, storage, average outflow and peak flow predicted 95.3%. In March the water storage is no more influenced by the inflow. The inflow is now reduced as the reservoir is no longer in flood, the storage is now drawn for generation, little outflow is permitted and peak inflow is no longer relevant. The stepwise model reduced the equation to 87.3% with storage and average outflow as the explanatory factors; suggesting that 12.7% of the explanation is due to other factors.

Y_1Mar= 102.252+0.12mininflow +0.41storage +0.21avgoutflow– 0.07pkinflow ....(eq.8)

(R^2 = (95.3%; SE = 15,052)

Y_2Mar = 102.252 + 0.411storage + 0.21avgoutflow ...(eq.9)

(R^2 = 87.3%; SE = 20,233)

d) April

In April the reservoir element had a weak prediction of the electricity generation. Three elements namely: peak outflow, storage and average inflow predicted 13.4% of the variance in the equation. This clearly shows that reservoir elements are poor predictor of power generation in April. This expected in view of the fact that, April is generally a period of low. The inflow variables are generally weak.

Y_1Apr=150,643.89+13,272.15pkoutflow+5,846.16storage+8,409.06avginflow .... (eq.10)

(R^2 =13.4%; SE = 53,887)

e) May

May marks the beginning of the rainy season around the Jebba area; hence some forms of local rains are received locally. Peak inflow is having a weak contribution into the reservoir, the level of the lake is been affected, evaporation is also an issue, it is higher than rainfall, but yet some amount of water still have to be spilled, therefore the outflows still plays a role in reservoir operations. These 3 elements account for 98.8% of the energy generated in the Jebba dam. Indeed, the reduce model showed that reservoir level alone account for 95.1% of power generation.

Y_1May=101.908-029pkinflow+0.599level+0.059avgoutflow +0.071evaporation. ..... (eq.11)

(R^2 = 98.8%; SE= 13516)

Y_2May = 101.908 + 0.599level ..... (eq.12)

(R^2 = 95.1%, SE = 14,561)

f) June

The white flood is already creeping in at the reservoir in June in view of the rainfall in some parts of the basin in northern Nigeria. Hence, inflow is now making an appearance, the output values of average outflow and discharge have to be controlled in other to allow the reservoir to fill. In June, minimum outflow, average outflow, reservoir level and discharge explained 96.9% of the total energy generated.

Y_1Jun = 101.834 + 0.151mininflow – 216avgoutflow + 0.613level – 0.135discarge .... (eq.13)

(R^2 = 96.9%, SE = 0.172)

Y_2Jun = 101.834 + 0.613level .... (eq.14)

(R^2 = 78.5%, SE = 0.34)

g) July

In July, the reservoir is also experiencing some level of influence of the white flood. The role of minimum inflow and reservoir level are more important. The outflow terms such as discharge are not contributing positively to power generation.The result of reservoir level is still a dominant variable in electricity generation as it account for 87.5% of power generation in July.

Y_1Jul = 154397.44 + 1006.24mininflow –3761.172discharge + 28614.9level .... (eq.15)

(R^2 = 89.1%; SE= 12,770)

Y_2Jul = 154397 + 28614.92level .... (eq.16)

(R^2 = 87.5%; SE = 11,567)

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h) August

In August the reservoir is getting filled up and some spillage have to be done in the reservoir and this account for the outflow terms of average outflow and discharge in other to protect the reservoir. Average outflow, storage and discharge account for 89.1% of the variance. The result of the stepwise regression shows that discharge explains 87.5% of the variance.

$$Y_1Aug = 154,397.44+1,006.24avgoutflow -3,761.17storage +28,614.9discharge \quad .... (eq.17)$$

$$(R^2 = 89.1\%; SE=12,770)$$

$$Y_2Aug = 154,397.44 + 28,614.9discharge) \quad ....(eq.18)$$

$$(R^2 = 87.5\%; SE = 11,567)$$

i) September

September is the supposed peak of the white flood in Jebba reservoir. Minimum inflow is dominant factor in the reservoir operation in September. Average outflow and level are weak contribution at this time. This is expected because the reservoir is getting filled up and the river is in flood. The inflow term has the highest contribution of 72.2% to the variance in the equation.

$$Y_1Sep = 135,306.22 + 28,935.17mininflow - 8,036.28avgoutflow – 4,718.74level \quad ..... (eq.19)$$

$$(R^2 = 79.7\%; SE = 19,413)$$

$$Y_2Sep = 135,306.22 + 289,335.17mininflow .... (eq.20)$$

$$(R^2 = 72.2\%; SE = 19,194.9)$$

j) October

The inflow terms are the most dominant, the river in Nigeria is now in flood as every area of Nigeria is now receiving rainfall. Peak inflow, storage and average inflow are very important to the explanation in the equation. The stepwise regression showed that peak inflow alone explained 84.4% of the variance.

$$Y_1Oct=161,752.89+39,670.67pkinflow+627.4storge+5,147avginflow \quad .... (eq.21)$$

$$(R^2=85.8\%; SE=20,583.1)$$

$$Y_2Oct = 161,752.89 +39,670.6pkinfow \quad ..... (eq. 22)$$

$$(R^2=84.4\%; SE = 18258.0)$$

k) November

The 'black flood' is already seeping in. average inflow and peak inflow is still dominant. Discharge is also very significant. These 3 elements contributed 54% explanation, while discharge also explains 51.6% explanation in the variance. The dominance of discharge is because at this time water is spilled.

$$Y_1Nov=146,223.56+5,847avginflow.12+3,002pkinflow+30716discharge \quad .... (23)$$

$$(R^2=54\%; SE = 38,691)$$

$$Y_2Nov=146,223.56+3,0716discharge \quad .... (24)$$

$$(R^2=51.6\%; SE= 31,796)$$

l) December

December marks the peak of 'black flood' and therefore one expect all the output terms to be most dominant. These are: peak outflow, minimum outflow, storage, discharge and evaporation all this explained 91% of the variance in the equation. This expected in view of the flood, the output terms became dominant since the reservoir have to be protected in view of the drawdown level is still high since the reservoir is just coming out of the 'white flood' of June to October. Hence, by November and December, the lake is still filled and the reservoir would have to be spilled. The high rate of evaporation is because of the high potential evaporation in Jebba.

$$Y_1Dec=302,460.67+133,615.69pkoutflow+114,877.49minoutput+203,774.95storage+87.610.17discharge+353,722.86evaporation \quad ..... (25)$$

$$(R^2=91.1\%; SE=231,078.96)$$

$$Y_2Dec= 302,460.67+353,722.86evaporation \quad ...... (eq.26)$$

$$(R^2=55.5\%; SE=338,524)$$

The above shows that reservoir elements played significant role in the explanation of electricity generation in 11 months except in the month of April when weak explanations were recorded. The results of the stepwise regression which was used as a reduce model shows that February andMarch have the highest numbers of factors (2 each). All others have 1 each with the exception of April whenno factorentered into the equation, Also, reservoir level has the highest entry (3 times) and peak outflow and minimum outflow have no entry at all.

V. Conclusion and Policy Implication

A causal relationship exists between electricity generation and power generation and reservoir elements in Jebba dam. This is expected since turbine operations depend on the reservoir management. If efficiency is expected in hydropower dams, the hydrologist must have detail knowledge about the interactions of the reservoir elements as guide to dam operation.

This research showed that fewfactors are most relevant to electricity generation. The level of relevance of these elements varies from months to month. However, during low flows the reservoir elements have negligible roles in power generation. Also in the flood seasons, the output termsare dominant in dam operations in other prevent dam failure and wastage of energy. In the off-peak runoff season the inflow attributes are dominant. The reservoir operator must therefore be familiar with all these details for efficient performance. There is a need for further study of the existence of redundancy in the performance of reservoir elements in Jebba dam.The power generation models derived in this study could be relevant in predicting power generation in Jebba and will provide a leeway in design an efficient reservoir rules.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & Print ISSN : 0975-5896

Boundary-fixed Homeomorphisms of 2-Manifolds with Boundary

By David J. Sprows
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Abstract - Let X be a closed, orientable 2-manifold and let X_n denote the bounded manifold obtained by removing the interiors of n disjoint closed disks from X . Let $H(X_n)$ denote the group of isotopy classes (rel boundary of X_n) of homeomorphisms of X_n which are the identity on the boundary of X_n. $H(X_n)$ has been determined for all n when X is the 2-sphere (see [8] and [10]). This paper investigates the structure of $H(X_n)$ for X not equal to the 2-sphere. In particular, a relationship between $H(X_n)$ and the homeotopy group (mapping class group) of X (see [4],[5] and [11]) is developed.

BOUNDARY-FIXED HOMEOMORPHISMS OF 2-MANIFOLDS WITH BOUNDARY

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Boundary-fixed Homeomorphisms of 2-Manifolds with Boundary

David J. Sprows

Abstract - Let X be a closed, orientable 2-manifold and let X_n denote the bounded manifold obtained by removing the interiors of n disjoint closed disks from X. Let $H(X_n)$ denote the group of isotopy classes (rel boundary of X_n) of homeomorphisms of X_n which are the identity on the boundary of X_n. $H(X_n)$ has been determined for all n when X is the 2-sphere (see [8] and [10]). This paper investigates the structure of $H(X_n)$ for X not equal to the 2-sphere. In particular, a relationship between $H(X_n)$ and the homeotopy group (mapping class group) of X (see [4],[5] and [11]) is developed.

I. Introduction.

Let X be a closed, orientable 2-manifold and let $D_1,...,D_n$ be disjoint closed disks in X with p_k a point in the interior of D_k for $1 \le k \le n$. Let $X_n = X - \bigcup_{k=1}^{n} Int(D_k)$ and $F_n = \{p_1,..., p_n\}$. This paper is concerned with the group $H(X_n)$ consisting of all isotopy classes (rel ∂X_n) of homeomorphisms of X_n which are the identity on the boundary of X_n. Note that in order for two boundary-fixed homeomorphisms of X_n to represent the same element in $H(X_n)$ not only must these homeomorphisms be isotopic, but also the isotopy between them must be the identity on the boundary of X_n for all values t, $0 \le t \le 1$. Presentations of $H(X_n)$ for all n in the case that X is the 2-sphere are given in [8]. In this paper it will be shown that if X is not the 2-sphere , then $H(X_n)$ can be obtained as part of a short exact sequence involving the free abelian group on n generators, denoted Z^n, and the subhomeotopy group of X consisting of all isotopy classes (rel F_n) of orientation preserving homeomorphisms of X which are the identity on F_n, denoted $H(X, F_n)$. This short exact sequence will then be used to relate $H(x_n)$ to the homeotopy group of X.

II. Boundry-fixed Homeomorphisms

let $f : H(X_n) \to H(X, F_n)$ be the function which sends the isotopy class (rel ∂X_n) of a boundary-fixed homeomorphism h of X_n onto the isotopy class (rel F_n) of the homeomorphism of X which is obtained by extending h by the identity over each disk D_k, $1 \le k \le n$. The function f is clearly well–defined since any isotopy (rel ∂X_n) of X_n can be extended by the identity on $\bigcup_{k=1}^{n} D_k$ to an isotopy (rel F_n) of X. In fact, f is an epimorphism since any orientation preserving homeomorphism of X which is the identity on F_n can be isotope (rel F_n) to a homeomorphism which is the identity on $\bigcup_{k=1}^{n} D_k$ (for details see Part3c of Lemma 3 of [7]). Moreover using Part 4 of Lemma 3 of [ ]we have that a homeomorphism of X_n is in the kernel of f is and only if it is isotopic to the identity. That is, the nontrivial elements of the kernel of f are represented by boundary-fixed homeomorphisms that are isotopic to the identity, but not by an isotopy that keeps the boundary of X_n fixed. The next two lemmas are concerned with finding representatives of the isotopy classes (rel ∂X_n) of such homeomorphisms.

Let $K(X_n)$ denote the kernel of f and let A_k be a collar neighborhood of ∂D_k for $1 \le k \le n$, with $A_i \cap A_j = \varnothing$ if $i \ne j$.

Lemma 1: Every element of $K(X_n)$ can be represented by a homeomorphism that is the identity on

$$X - \bigcup_{k=1}^{n} Int(A_k)$$

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Proof : Let h be a homeomorphism that represents an element of $K(X_n)$ and let h_t be an isotopy that takes h to the identity. Using the "unwinding " technique of Proposition 3.22 of [6] it is possible to extend h_t^{-1} / X_n to an isotopy g_t of X_n that takes the identity to a homeomorphism that is the identity on $X - \bigcup_{k=1}^{n} Int(A_k)$. The isotopy $g_t h_t$ is then an isotopy (rel ∂X_n) that takes h to a homeomorphism of the type given in the statement of the lemma.

For each *k*, $1 \le k \le n$, let $s_k^r : X_n \to X_n$ be defined by letting s_k^r restricted to the annulus A_k be the homeomorphism given in which spins one component of ∂A_k r-times while holding the other boundary component fixed and by letting s_k^r restricted to $X_n - A_k$ be the identity. s_k^r will be referred to as a"spin homeomorphism " of X_n.

Lemma 2 : If X is not the 2-sphere , then every element of $K(X_n)$ has a unique representation as a product of spin homeomorphisms.

Proof : A consequence of Theorem 7.2 of [3] is that every homeomorphism of A_k which is the identity on ∂A_k is isotopic (rel ∂A_k) to s_k^r / A_k for some r. Since A_i is disjoint from A_j for $i \neq j$, this means that any homeomorphism of X_n which is the identity on $X - \bigcup_{k=1}^{n} Int(A_k)$ is isotopic (rel ∂X_n) to a product of homeomorphisms of the form $s_1^{r_1} \cdots s_n^{r_n}$. Thus by Lemma 1, every element of $K(X_n)$ can be represented by a product of spin homeomorphisms.

To show that the representation if unique it suffices to show that if $s_1^{r_1} \cdots s_n^{r_n}$ is isotopic (rel ∂X_n) to the identity, then $r_i = 0$ for $1 \le i \le n$ .On the contrary, assume this product is isotopic (rel ∂X_n) to the identity, but $r_k \neq 0$ for some k. Let α be a curve which represents a generator of $\pi_1(X,q)$ where q is in ∂D_k and α is chosen so that $\alpha \cap A_j = \varnothing$ for $i \neq j$ and $\alpha \cap D_k = \{q\}$. Let β_k be a curve based at q which wraps once around ∂D_k in the direction of the spin corresponding to $s_k^{r_k}$. In the free group $\pi_1(X_n,q)$, the spin homeomorphism $s_k^{r_k}$ represents the same element as $\beta_k^{-r_k} \alpha \beta_k^{r_k}$. However, since $s_1^{r_1} \cdots s_n^{r_n}$ is isotopic (rel ∂X_n) to the identity and α is outside the support of $s_i^{r_i}$ for $i \neq k$, we have that $s_k^{r_k}(\alpha)$ must also represent the same element as α in the free group $\pi_1(X_n,q)$. This contradiction establishes the lemma.

It should be noted that Lemma 2 is false in the case that X is the 2-sphere and $n < 3$. For example, when X is the 2-sphere and $n = 1$, then every spin homeomorphism of X_1 is isotopic (rel ∂X_1) to the identity (see [8]).

The nest theorem is an immediate consequence of the fact that since the elements of $K(X_n)$ can be represented uniquely as products of spin homeomorphisms and these spin homeomorphisms all commute, the kernel of the epimorphism f is the free group on n generators.

Theorem : If X is not the 2-sphere, then the following sequence is exact.

$1 \to Z^n \to H(X_n) \to H(X,F_n) \to 1$ where the function from $H(X_n)$ to $H(X,F_n)$ is given by f as defined at the beginning of this section.

The above theorem shows that $H(X_n)$ can be obtained as an extension of Z^n by $H(X,F_n)$. In turn $H(X,F_n)$ is part of the short exact sequence $1 \to \pi_1(X - F_{n-1}, p_n) \to H(X, F_n) \to H(X, F_{n-1}) \to 1$ where the function from $H(X,F_n)$ to $H(X,F_{n-1})$ sends the isotopy class (rel F_n) of a homeomorphism of X to the isotopy class (rel F_{n-1}) of this homeomorphism. If we denote this function d, then the representation of an element in the kernel of d as an element in $\pi_1(X - F_{n-1}, p_n)$ is obtained by taking the curve formed by tracing the path of p_n during the isotopy (rel F_{n-1}) which takes a representative homeomorphism of an element in the kernel of d to the identity.

Thus, we can build up $H(X,F_n)$ from the homeotopy group of X, $H(X)$, by repeatedly extending $\pi_1(X - F_k)$ by $H(X,F_k)$ for $k = 1, \cdots, n-1$ (see [1] and [2]).

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & Print ISSN : 0975-5896

Microbiological Risk Assessment and Anti-Microbial Activities of Azadirachta Indica Stem Extract against Sanitary Indicator Bacteria Associated with Kunnu Samples

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Keywords : Microbiological risk assessment, A. indica, susceptibility, kunnu, sanitary indicator bacteria.

GJSFR-G Classification : FOR Code: 060504, 060503

MICROBIOLOGICAL RISK ASSESSMENT AND ANTI-MICROBIAL ACTIVITIES OF AZADIRACHTA INDICA STEM EXTRACT AGAINST SANITARY INDICATOR BACTERIA ASSOCIATED WITH KUNNU SAMPLES

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Keywords : Microbiological risk assessment, A. indica, susceptibility, kunnu, sanitary indicator bacteria.

I. Introduction

Kunnu is a cereal-based beverage in Nigeria. It is marketed in all parts of Nigeria; the cereals used in its production are Millet, sorghum, and maize in decreasing order of preference (Gaffa, et al., 2002, Nwachukwu, et al., 2009).

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Non-alcoholic beverages play a very important role in the dietary pattern of people in developing countries like Nigeria. They are regarded as after meal drinks or refreshing drinks during the dry season in rural and urban centres. The sorghum grain Kunu-Zaki has about 76.3% starch, 11.6% proteins, 3.3% fat 1.9% fibre and 1.3% ash along with a wide array of amino-acids (Lichtenwalner *et al.*, 1979). The additive that is used is sweet potatoes; it contains essential amino acid and is a rich source of vitamins (Osuntogun and Aboaba, 2004).

It provides a source of income and a means of poverty alleviation and contributes to variety in the diet and the food security of millions. Small-scale food industry also provides linkages to local suppliers of agricultural raw materials and to income generating activities such as the manufacture of machinery, packaging and ingredients (FAO, 1997). The traditional production process involves: steeping the grain in a local household utensils such as calabashes, and earthen were vessels and grinding of the stepped grain with ginger in grinding machines to pulverize the grains for enzymatic actions. (Adeyemi and Umar, 1994; Onuorah, *et al.*, 1987).

The traditional production of Kunu is still at village technology level. The process of production involves wet milling of the cereal, wet sieving, partial gelatinization of the slurry, sugar addition and bottling (Adejuyitan *et al.,* 2008). The fermentation process may last for 12-72hours (Gaffa and Ayo, 2002) after which it is kept for acidification to develop.

The quality of the drinks therefore depends on the raw materials and the hygiene of the personnel, water and the production environment. Brief fermentation, involving mainly lactic acid bacteria and yeast, usually occurs during sleeping of grains in water over 8-48 hours (Odunfa and Adeleye, 1985). The consumption rate of the beverage has also been studied (Gaffa and Ayo, 2002). Owing to the high demand for this product and the high consumption rate, it is thought that the present traditional production process is outdated, inefficient, time consuming and with product quality varying between batches.

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Most of these beverages are made up of about 90% of water, sugar, flavouring agents and sometimes preservatives (Osuntogun and Aboaba, 2004) but some of the waters used for kunu processing such as wells and boreholes are prone to contamination from various sources. It has been reported that the microbiological quality of most of the pipe borne and well water supplies to some communities in Nigeria is poor with *coliform* counts far exceeding the level recommended by WHO (Adesiyun 1983). Feacal contamination of water supplies and contaminated food handlers has most frequently been implicated in the outbreak of food poisoning caused by *Escherichia coli* (Adams and Moss, 1999). Unsafe water is a global public health threat, placing persons at risk for a host of *diarrheal* and other disease as well as chemical intoxication Hughes and Koplan, 2005,

Pathogens such as *Bacillus cereus, Salmonella sp* and *Escherichia coli* are naturally present in some soil, and their present on fresh produce is not rare. Salmonella, *Escherichia coli* 0157:H7, *Campylobacter jejuni, Vibrio cholerae,* parasites, and viruses are more likely to contaminate foods most especially ready to eat food.

The presence of the amount of sanitary indicator organisms in foods are of importance in the assessment of the quality and safety of foods (Egwaikhide and Faremi, 2010); Edema *et al.,* (2008) reported that in developing countries, despite the appeared death of sustainable disease surveillance and reporting, it is widely known that cholera, Salmonellosis, Shigellosis, Typhoid, Brucellosis, Poliomyelitis and *Escherichia coli* infections are prevalent (FAO/WHO, 2003). A major obstacle in the consumption of Kunu is the outbreak of *listeriosis*, a food borne disease called *listeriosis*, is caused by *listeria monocytogenes*, a gram positive, facultative anaerobe which occurs singly or in pairs, also in short chains. (Murray et al, 2002). Even though, epidemiological evidence on outbreaks of food borne disease as a result of taking kunu is scarce, there are indications that it could still be contaminated to unsafe level at the point of consumption with air flora an other microorganisms from handlers, equipment serving containers, raw materials and lack of portable water for processing. This indicates the need for more effective methods to control microbial access to foods through efficient sanitation that helps to produce food that, when properly handled and stored, will have a long shelf life and reduce incidence of food born diseases (Marriot, 1989 Cords and Dychdala, 1993).

Bacterial resistance to antibiotics represents a serious problem for clinicians and the pharmaceutical industry and great efforts are being made to reverse this trend, and one of them is widespread screening of medicinal plants from the traditional system of medicine hoping to get some newer, safer, and more effective agents that can be used to fight infections diseases (Natarajan et al, 2003). *Azadirachta indica* is one of such medicinal plants belonging to the family *Meliaceae* and is Indigenous to southern Asia (Akula et al., 2003).

It is an extensively popular tree in Nigeria and is commonly referred to as "Neem" (English), "Dogon Yaro" (Hausa), "*Gaadina*" (Fulfulde) and "Akun Shorop" (Igbo). *Azadirachta Indica* is a multi - purpose timber tree from which high value products are extracted for use as an insecticide, fertilizers and multipurpose medicines. *Azadirachta indica*, it is popularly known as the village dispensary (Akula et al., 2003).

The therapeutic efficacies of the *Azadirachta Indica* have been described by practioners of traditional medicine. Some of the *ethnomedicinal* uses included treatment of skin disorders, rashes and boils, stomach ulcer, rheumatism, respiratory tract infections, sore gums and throat, eye and ear infections, leprosy and diabetes (Isman *et al.*, 1990; Kaura *et al.*, 1998, Akula *et al.*, 2003). Also, the medicinal uses has been reported by several workers and these includes having antipyretic (Okpanyi and Ezenkwa, 1981), antimalaria (Tella, 1977), anti-tumour (Fujiwara *et al.,* 1982), anti-ulcer (Pillai and Santhakumari, 1984) antidiabetic (Shukla *et al.*, 1984) and cardiovascular properties (Thompson and Anderson, 1978). In a precious survey of plant used for the treatment of ear and eye infections, amongst the practitioners of traditional medicine and other knowledgeable rural dwellers in the northern parts of Nigeria, the neem seed was listed as one of the most popular source of medicaments.

The microbiological safety of food and water is achieved by as far as possible ensuring the absence of pathogenic microorganisms and by all means preventing their multiplication (Edema and Omemu, 2004). Nearly, 90% of *diarrheal* related deaths have been attributed to unsafe or inadequate water supplies and sanitation (Younes and Bartram 2001; WHO, 2004).

This work is aimed to determine the microbiological risk assessment of kunnu sold in ilorin metropolis and also to evaluate the therapeutic values of *methanolic* extract of *A. indica* against isolated sanitary indicator bacteria associated with the purpose of improving its quality using botanical compound to serve as preservatives.

II. Materials and Methods

a) Sampling Procedures

Ten samples each of Kunnu beverages from ten different locations within Ilorin metropolis were purchased in plastic containers that were washed with 70% ethanol and rinsed twice with sterile distilled water. They were labeled at the point of purchased and transported to the lab within 4hours after sampling.

b) Microbiological Evaluation

Ten milliliter(10ml) of each sample were aseptically transferred into 90ml of 0.1% sterile peptone water, appropriate dilutions (up to 10^5) were prepared, 0.2ml of inoculums was plated on each plates (Harrigan

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and McCance, 1976) has reported by Edema et al., (2008); (Fawole and Oso 2001); (Oranusi, 2003). *Aerobic mesophiles* were made on plate count agar (oxoid, UK) coliform count on *MacConkey* agar, *E.coli* on Eosin Methylene Blue agar, *Staphylococcus* sp on Manitol Salt Agar, PALCAM agar on *Listeria sp*. (oxoid, UK).

One milliliter (1ml) of the aliquot from serially diluted samples was plated on each of the media using pour plate method for the enumeration of the bacteria associated with the kunnu samples. Ten milliliter (10ml) of the samples was enriched in *selenite* F and incubated for 24hours thereafter plated on *salmonella shigella* agar (SSA) .All the plates were incubated at 37^{0}C for 48hours. All the colonies were subcultured and stored in a stock culture before used.

c) Antimicrobial susceptibility testing

A standard disc diffusion method of (Jorgensen and Turnidge 2003) was used. The antibiotics used are, Penicillin G10 units, Cephalosporin 30µg, Bacitracin 10 units, Streptomycin 10µg, Ampicillin 30µg, Gentamicin 10µg, Erythromycin 10µg, Tetracycline 3µg, Ciprofloxacin 5µg, Chloramphenicol 30µg, Kanamycin 10µg.

d) Collection of plants

Stem of *Azadirachta indica* (Neem plant) were collected from Kwara State polytechnic main campus, Ilorin and authenticated at the department of Plant Biology, University of Ilorin.

e) Plant extraction preparation

The plant materials used (*A. indica*) were collected and dried in shade. The dried stem were grounded to power and suspended in petroleum ether and kept in refrigerator overnight for removing all the fatty substances, overnight incubation the supernatant was discarded and the residue was dried at room temperature. 50mgs of residues were soaked in 250ml of methanol and kept at 4^{0}C overnight; the supernatant was filtered and dried to evaporate the organic solvent at room temperature. The *sedimented* extract was weighed and dissolved in 0.1% *Dimethyl Sulfoxide* (DMSO) to get 100mg/ml concentration. (Natarajan *et al.*, 2003)

f) Standardization of inoculum

The selected sanitary indicator bacteria isolated from kunu samples were standardized to that of the 0.5 *Macfarland* standard (1.5 x 10^8 cfu /ml) by adding sterile distilled water.

g) Inhibition assays

Bacterial isolates were cultivated in nutrient broth at 35^{0}c for 2-6 hours to achieve standardized inoculum (1.5 x 10^{8}cfu/ml) of each of the isolated sanitary indicator bacterium (in duplicates) swabs were dipped into their suspension and then streaked over the surface of the Mueller Hinton agar and allowed to dry for 15minutes before the antibiotic discs were applied. The diameters of zone of inhibition were recorded after incubation at 37^{0}c for 24hours.

h) Evaluation of antimicrobial activity

The preliminary antimicrobial screenings of the *methanolic* extract of the plant was carried out using the agar diffusion techniques (Singleton, 1999, Ahmed and Beg, 2001; Pundir, *et al.*, 2010). Mueller Hinton agar plates were inoculated with 0.1ml of standardized *inoculum* (1.5 x 10^8 cfu/ml) of each selected bacterial isolate and spread with sterile swabs. A standard cork borer of 8mm diameter was used to cut uniform wells in agar plates containing the bacterial *inoculum* and the lower portion was sealed with molten agar medium. A 0.1ml volume of the crude plant extract was poured into a well of inoculated plates. The plates were incubated at 37^{0}c for 24hours after which diameters of zone of inhibition were measured (Obiukwu and Nwanekwu, 2009, Pundir *et al.*, 2010).

i) Antibacterial activity

Antibacterial activity was recorded if the zone of inhibition was greater than 8mm (Hammer et al, 1999) as reported by Pundir *et al.*, (2010). The antibacterial activity results were expressed in terms of the diameter of zone of inhibition and <9mm zone was considered as inactive; 9-12mm as partially active, while 13-18mm as active and >18mm as very active (Junior and Zanil, 2000).

j) Determination of the minimum inhibitory concentration (MIC)

The MICs of the *methanolic* plant extract was determined using *macrodilution* broth method of (Pundir *et al.*, 2010) with little modification. A twofold serial dilution of the extract was prepared in sterile Mueller-Hinton broth to achieve a decreasing concentration ranging from (200 to 1.56mg/ml. Each dilution was (1.5 x 10^8 cfu/ml). The inoculated tubes were incubated at 37^{0}c for 24 hours. The MIC was taken as the lowest concentration that inhibited the growth of the organism from the tubes. A100µl of the content was plated out onto the surface of agar medium and then incubated for 24hours at 37^{0}c. MBC is then taken as the lowest concentration without growth of organism on the agar plate.

III. Results and Discussion

Microbiological risk assessment of Kunu and *antimicrobial* activity of *Azadirachta indica* stem extract against sanitary indicator bacterial was evaluated. Antibiotic susceptibility pattern and *invitro* therapeutic efficacy of *Azadirachta indica* stem extract was determined. This study indicated that the Kunnu samples were grossly contaminated with high plate count of 7.2 x 10^6 cfu/ml. Total *Salmonella/Shigella* plate count, *Listeria monocytogenes counts,* Total Staphylococcal count, total *coliform count* and *E.coli*

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were ranged between ($12x10^1$ – 7.6×10^3) cfu/ml, ($4.8x10^2$ – $25x10^4$)cfu/ml, ($9.4x10^1$ – $1.0x10^4$)cfu/ml ($0.30x10^2$ – $1.36x10^5$)cfu/ml and ($0.21x10^1$ – $27x10^3$)cfu/ml respectively as shown in table 1.

All the tested *Enterobacteriacea* were not susceptible to all the selected β-lactam antibiotics, the investigation showed considerable variation in susceptibility pattern depending on the species as shown in table 2.

Erythromycin, Gentamycin, Cephalosporin, Ciprofloxacin and Chloramphenicol showed high level of antimicrobial activity against the tested isolates, while they displayed about 40% resistance to Penicillin, Streptomycin, Bacitracin, and Ampicillin. Methanolic extract of *A. Indica* stem showed inhibitory activity against all the bacterial isolates in which diameter of zone of inhibition, MIC and MBC ranged between 15-28mm, 3.125-50mg/ml and 3.125-100mg/ml respectively. *E.coli* showed highest zone of inhibition of 28mm with 3.125mg/ml and 6.25mg/ml of MIC and MBC respectively while *Pseudomonas sp* showed lowest zone of inhibition of 15mm and 50-100mg/ml for MIC and MBC respectively.

Table1 : prevalence and occurrence of sanitary indicator bacteria associated with kunnu (cfu/ml)

Location	Total Plate count	*Salmonella / Shigella*	*Listeria monocytogenes*	*Total Staphylococcal count*	*Total Coliform Count*	*E.coli*
A	$7.2x10^6$	$12x10^2$	45×10^3	5.7×10^3	1.36×10^5	$27x10^3$
B	1.36×10^5	-	1.02×10^2	4.3×10^2	7.5×10^3	$13x10^2$
C	3.3×10^5	76×10^3	-	6.1×10^2	1.20×10^5	$81x10^2$
D	1.60×10^5	22×10^2	67×10^1	9.4×10^1	0.80×10^4	$61x10^2$
E	8.0×10^4	-	-	-	0.30×10^2	$0.21x10^1$
F	118×10^6	12×10^1	25×10^4	4.6×10^3	4.4×10^3	$15x10^1$
G	1.0×10^6	49×10^2	7.8×10^3	1.8×10^2	1.5×10^4	$30x10^2$
H	1.30×10^5	-	-	1.0×10^4	2.30×10^3	-
I	1.10×10^5	-	-	-	1.48×10^3	$23x10^1$
J	5.0×10^4	10×10^2	4.8×10^2	5.5×10^2	4.0×10^3	$1.0x10^2$

Table 2 : Drug susceptibility pattern of sanitary indicator bacteria isolated from kunnu samples (mm)

Antibiotics	*Salmonella.sp*	*Staph. aureus*	*Pseudomonas,sp*	*K. pneumonia*	*L.monocytogene*	*E.coli*
Penicillin G.(10 units)	2.0	27.0	0.0	4.0	11	0.0
Cephalosporin(30µg)	23	11.0	14.0	30	21	28
Bacitracin (10units)	0.0	19.0	0.0	0.0	13	0.0
Streptomycin (10µg)	17	8.0	10	24	17.0	21
Ampicillin (30 g)	3.0	26.0	04	06	14.0	13
Gentamicin (10µg)	23.0	15.0	11	20	15.0	23
Erythromycin (10µg)	10.0	26.0	11	14	13.0	18
Tetracycline (30µg)	6.0	19.0	4.0	14	19.0	17
Ciprofloxacin (5µg)	23.0	13.0	15	25	14.0	18
Chloramphenicol (30µg)	15.0	18	17	21	11.0	20

Table 3 : Susceptibility of the Sanitary Indicator Bacteria to Methanolic extract of *Azadirachta* indica (Neem plant)

Test Organisms	Zone Of Inhibition (Mm)	MIC (Mg/Ml)	MBC (Mg/Ml)
Salmonella sp	22	6.25	12.5
Staphylococcus aureus	26	3.125	3.125
Pseudomonas sp	15	50	100
Listeria monocytogene	17	25	50
Klebsiella pneumoniae	25	6.125	12.5
E.coli	28	3.125	6.25

Sanitary indicator bacteria such as total *coliform*, *E.coli*, *listeria monocytogenes*, *Staphylococcus* and *Salmonella* were used to measure hygienic level of kunnu and handling process in this study. The occurrence of food borne pathogens and sanitary indicator bacteria in this study is an indication that the Kunnu samples sold in Ilorin are neither microbiologically safe nor hygienic.

Poor hygiene practices of the food handlers during preparation might have been contributed to their presence as suggested by Mosupye (1999) that the presence of indicator organisms in food may be attributed to poor personal hygiene, poor practices among food handlers and cross contamination from either the environment, water used for processing or serving bottles and this can lead to foodborne illnesses.

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High bacterial load of Kunnu in this investigation agreed with the result of (Gaffa *et al.,* 2002, Chukwu *et al.,* 2006). Waikhide and Faremi, (2010); suggested that the possible sources of these organisms in the food samples could be from nose, hand, skin and clothing of handlers, coughing, talking and sneezing droplets which could settle on the food during storage and retailing (Omonigho and Osubor, 2002 and Ojokoh and Tabowei 2002). Besides, high number of bacterial load can also be attributed to raw materials and water used for production process (Nwachukwu *et al.*, 2009).

The presence of the most frequently isolated index of water quality and indicators of *faecal* contamination such as *E.coli*, total *coliform* and *salmonella sp* in this study is an indication of *faecal* contamination of the water used for processing coupled with poor environmental sanitation (Trevett et al., 2005).

Water fetched from wells and taps were transferred into containers, facilities that are not washed for several days, leaving sediments to settle at the bottom which might served as source of contamination and unhygienic handling of food. The isolation of *staphylococcus sp*, *Salmonella sp* and *Pseudomonas sp* in this study is of practical importance and it is an evidence of poor sanitary condition and lack of adequate portable water.*Salmonella* contamination is usually associated with food and animal *feaces* and its presence in this study is a signal of *faecal* contamination of both human and animal origin (Dondero, 1977).

In this study a multidrug resistance pattern was observed for *E.coli, Salmonella sp* and *Pseudomonas sp* with ampicillin, bacitracin and tetracycline. Bacteria species were susceptible to the ciprofloxacin, gentamicin. erythromycin, ciproploxacin and chloraphenicol. Resistance to tetracycline and ampicillin might be related to their overuse as opposed to gentamicin and ciprofloxacin which are not used for treating enteric infection in agreement with (Onyuka *et al.*, 2011).

The high prevalence of resistance to tetracycline, ampicillin in *E.coli* has also been reported by Sifuna, in which E.coli was resistance mostly to ampicillin and tetracycline. Sack, 2001 and Shapiro, 1999 attributed resistance to use of tetracycline of mass prophylaxis during cholera or diarrhea.

None of the pathogens were resistant to *ciprofloxacin*, several studies have shown that ciprofloxacin offers advantages in the treatment of *salmonellosis* reaching high concentrations in serum and *faeces* (Threlfall, 2001;Eduardo, *et al.*, 2001).

The antibacterial activities exhibited by this plant extracts reported here corroborates the finding of other researchers who worked on the antimicrobial activities of this plants on the isolated indicator bacteria (Rao et al, 1986, Tuhin et al; 2007, Koona and Budida, 2011). That methanol extract in this study might have had higher solubility for more *phyto* constituents, consequently the highest antibacterial activity. The *methanolic* extract of *Azadirachta indica* exhibited antibacterial effect (Jafri and Jalis – sub-Hani 1999, Samy and Ignacinauth, 2000). (Koona and Budida 2011) and also demonstrated how MIC and MBC values is an indication that the *pyto* constituents of the plant have therapeutic properties (Doughari *et al*, 2008).

The antibacterial activity of *Azadirachta Indica* might be due to the presence of *triterperiods*, *phenolic* compounds, *carotenoids*, steroids, *valavinoids*, *ketones* and tetra-*triterperiods Azadirachtin* (Koona and Budida 2011).

The findings from the agar diffusion methods showed that the extract exhibit a favourable antimicrobial activity against indicator bacteria. Some of the MIC values obtained in this study were lower than MBC values indicating that the plant extract is *bacteriostatic* at lower concentration and *bacteriocidal* at higher concentration (Zakaria *et al*, 2007).

The standard organization of Nigeria (1985) stated that *coliform* bacteria and pathogenic microorganisms should not be present in beverages. This applies also to other food products. It was reported that counts of 10^7 Cells/g for *Bacillus* cereus (1CMSF, 1974), and 10^6 cells/g for *enterotoxigenic staphylococcus aureus* (Bergdoll, 1979) are required to present a risk of intoxication.The presence of *coliform* and *staphylococcus aureus* and processing and packaging in a contaminated environment could present a risk (Okonko *et al.,* 2008).The need for microbial assessment of water for production of sea food and food drinks should also be emphasized to reduce possible contamination as reported by Fagade *et al.,* (2005).

IV. Conclusion/Recommendation

Control of both pathogens and spoilage bacteria in kunnu becomes important in order to produce food that when properly handled and stored, will have a long shelf life and reduce the incidence of food borne diseases. This indicates the need for more effective methods such as HACCP to control microbial access through efficient sanitation and good manufacture practices. However, it can be recommended that the stem extract of the A. indica can serve as preservatives to control microbial growth in kunnu.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

A Comprehensive Analysis of Amount of Liquid in a Horizontally Mounted Right Cylindrical Tank

By Md.Saiful Islam, Md.Alamgir Hossain, Md.Abdullah al Mamun, Md.Jahidul Islam

University of Engineering & Technology DUET, Bangladesh

Abstract - A cylindrical tank, when it is kept its circular surface downward & upward than the liquid level varies uniformly and the variation of amount of liquid with the height of the tank is linear. It is easy to calculate but the problem arises when the curved surface of the tank is kept as base i.e. the tank is horizontally mounted then the variation of liquid amount along diameter is not linear. Here the height is calculated along the diameter. In most of the industries especially in chemical industries and in heavy vehicles the liquid tank is horizontally mounted. At the present existing liquid an amount of discharge calculation at every instant from height of liquid has been solved using various conditions, algebras and geometrical theorems.

Index Terms : At this juncture some conventional symbol like triangle (Δ), liquid difference Δ S some non conventional term like Smax S has been used to express liquid amount.

GJSFR-E Classification : FOR Code: 010203

A COMPREHENSIVE ANALYSIS OF AMOUNT OF LIQUID IN A HORIZONTALLY MOUNTED RIGHT CYLINDRICAL TANK

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A Comprehensive Analysis of Amount of Liquid in a Horizontally Mounted Right Cylindrical Tank

Md.Saiful Islam [α], Md.Abdullah al Mamun [Ω], Md.Alamgir Hossain [β], Md.Jahidul Islam [ψ]

Abstract - A cylindrical tank, when it is kept its circular surface downward & upward than the liquid level varies uniformly and the variation of amount of liquid with the height of the tank is linear. It is easy to calculate but the problem arises when the curved surface of the tank is kept as base i.e. the tank is horizontally mounted then the variation of liquid amount along diameter is not linear. Here the height is calculated along the diameter. In most of the industries especially in chemical industries and in heavy vehicles the liquid tank is horizontally mounted. At the present existing liquid an amount of discharge calculation at every instant from height of liquid has been solved using various conditions, algebras and geometrical theorems.

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I. Introduction

In a vertically mounted tank, the variation of liquid is done along the length of the tank .In that case the circular base is fixed and always immersed with liquid. So it can be calculated using general conventional rule [1].But when height varies along the diameter that has been done by means of various methods. Firstly the area of the portion of circular face is immerged by liquid has been calculated. That is done by calculating fractional area of the circle [2].Using Pythagorean Theorem [3], we get the dimensions .According to the solid geometry get the formula of volume & amount of liquid in liter [4].To show the liquid level & vessels we use AutoCAD [5].The variation of amount of liquid to height of liquid is plotted by MATLAB [6].In vertical & Horizontal position, the entire tank volume is kept identical. That is why the general conditions satisfy in both positions of the tank. Finally the discharge or entrance of liquid is computed using the developed formula. This formula can be used to calculate any kind of measurement of liquid and its discharge or entrance.

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II. Vertically Mounted Tank

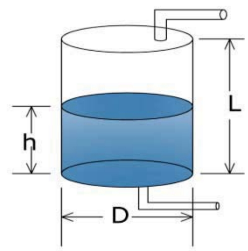

Figure 2.1 : Vertically mounted tank

The volume of the tank may be expressed as
V=area of base × height of liquid

$$V = \frac{\pi}{4} D^2 h \quad \text{...... (2.1)}$$

Where,
D= inner Diameter of the circular base.
h= inner Height of the liquid level.
L= inner Length of the tank.
V=inner volume enclosed by the liquid.
π =3.1416

If D, L, and h are expressed in **meter** then the volume V will be in cubic **meter.**

We know 1 cubic meter volume contain 1000 liters of liquid.
So amount of liquid expressed in liters in tank

$$S = \frac{\pi}{4} D^2 h \times 100 \quad \text{...... (2.2)}$$

i.e. $S = 250\pi D^2 h$ ...... (2.3)

When h=0 , S=0
When h=L/2, $S = 125\pi D^2 L$ ...... (2.4)
When h=L. The tank is completely filled with liquid i.e. maximum filled.

$$S_{max} = 250\pi D^2 L \quad \text{...... (2.5)}$$

III. Horizontally Mounted Tank

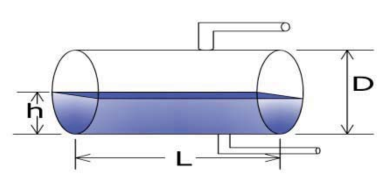

Figure 3.1 : Horizontally mounted tank

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Global Journal of Science Frontier Research Volume XI Issue VIII Version I November 2011

When the curved surface of the tank is kept as base i.e. the tank is horizontally mounted at that time the variation of liquid along diameter is observed.

The variation of area of liquid occupied region need to find out first.Figure-3.2 & Figure-3.3 shows the projection of two different levels of liquid.

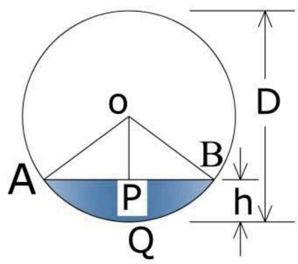

Figure3.2 : When the liquid level is under the Center i.e. h<D/2

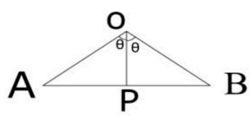

Figure 3.3 : Δ AOB

Assume that the liquid surface i.e. chord AB creates an angle 2θ in the centre of the circle.

I.e. ∠AOB=2θ

OA=OB = radius of the circle = D/2

OP is perpendicular to AB[7] .we can write AP=BP.OP is common the side within Δ AOP & Δ BOP.

So the Δ AOP & Δ BOP are equal in all respects [7].

Hence that <AOP=<BOP = θ.

And , $$OP = \left(\frac{D}{2} - h\right). \qquad ...... (3.1)$$

Using Theorem of Pythagoras we have

$$AP = BP = \sqrt{\frac{D^2}{4} - \left(\frac{D}{2} - h\right)^2}. \qquad ...... (3.2)$$

$$= \sqrt{\frac{D^2}{4} - \left(\frac{D^2}{4} + h^2 - 2.\frac{D}{2}.h\right)}$$

$$= \sqrt{\frac{D^2}{4} - \frac{D^2}{4} - h^2 + D.h}$$

$$= \sqrt{D.h - h^2}$$

$$\therefore AB = 2AP = 2\sqrt{D.h - h^2}. \qquad ...... (3.3)$$

So the area of the Δ AOB is,

$$= \frac{1}{2}.AB.OP.$$

$$= \frac{1}{2}.2.\sqrt{D.h - h^2}\left(\frac{D}{2} - h\right).$$

$$= \sqrt{Dh - h^2}\left(\frac{D}{2} - h\right). \qquad ...... (3.4)$$

Since a circle creates 360 degree in centre and ∠AOB = 2 θ. Therefore area of the region AOBQ [2] is equal to

$$= \frac{2\theta}{360^0} \times \text{Full area of the circle.}$$

$$= \frac{\theta}{180} \times \text{Full area of the circle.}$$

$$= \frac{\theta}{180^0} \times \pi \frac{D^2}{4}$$

$$= \frac{\pi\theta}{720} D^2 \qquad ...... (3.5)$$

Hence the area of the liquid region APBQ will be equal to the subtraction result of Δ AOB from region AOBQ in Figure-3.2 but in Figure-3.3 will be addition result of them.

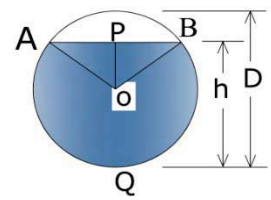

Figure 3.4 : When the liquid level is above the Center i.e. h>D/2

This is done, when the value of h is less than D/2 the value of (D/2-h) is positive but when h is greater than D/2 , (D/2-h) is negative.

So the area of the liquid region APBQ is

$$= \frac{\pi\theta}{720} D^2 - \sqrt{D.h - h^2} \times \left(\frac{D}{2} - h\right) \qquad ...... (3.6)$$

Again from Figure-3.2 the value of θ in degree

$$\theta^0 = cos^{-1}\frac{OP}{OA}$$

$$= cos^{-1}\frac{\frac{D}{2} - h}{\frac{D}{2}}$$

$$\theta^0 = cos^{-1}\left(1 - \frac{2h}{D}\right) \qquad ...... (3.7)$$

So the volume of the liquid in the tank [1]

$$V = [area \times length]$$

V=area of liquid region APBQ ×length of the tank.

$$V = \left[\frac{\pi D^2}{720} cos^{-1}\left(1 - \frac{2h}{D}\right) - \sqrt{D.h - h^2}\left(\frac{D}{2} - h\right)\right].L \qquad ...... (3.8)$$

Now if diameter D, length L, height h is expressed in meter then the volume will be in cubic meter.

So the amount of liquid in liter

$$S = V \times 1000$$

$$S = 1000L\left[\frac{\pi D^2}{720} cos^{-1}\left(1 - \frac{2h}{D}\right) - \sqrt{D.h - h^2}\left(\frac{D}{2} - h\right)\right] \qquad ...... (3.9)$$

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IV. Comparison

a) Graphical Comparison

At this point the plots are drawn for same size tank i.e. all the dimensions are same but position is different.

Figure - 4.1 : shows the relationship between S & h in a vertically mounted tank & this is linear. Using equation (2.1) for a vertically mounted tank ,

When h=0 , S=0

When h=L/2 , $S = 125\pi D^2 L$

When h=L, $S_{max} = 250\pi D^2 L$

For horizontally mounted tank using equation (3.9)

When h=o S= o

When h=D/2 $S = 125\pi D^2 L$

When h=D $S_{max} = 250\pi D^2 L$

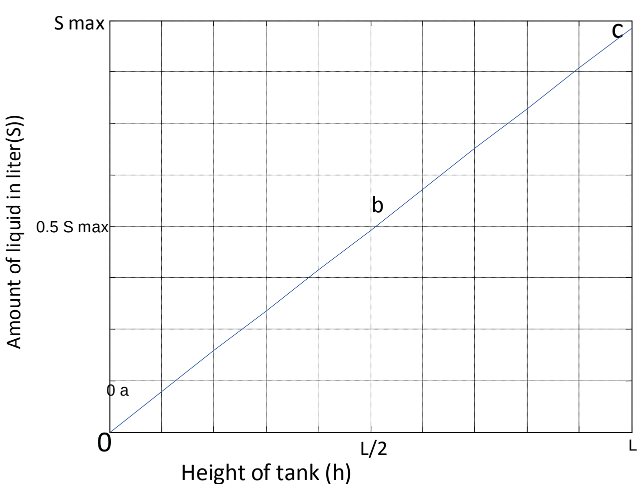

Figure 4.1 : The relationship between S & h in a vertically mounted tank & this is linear.

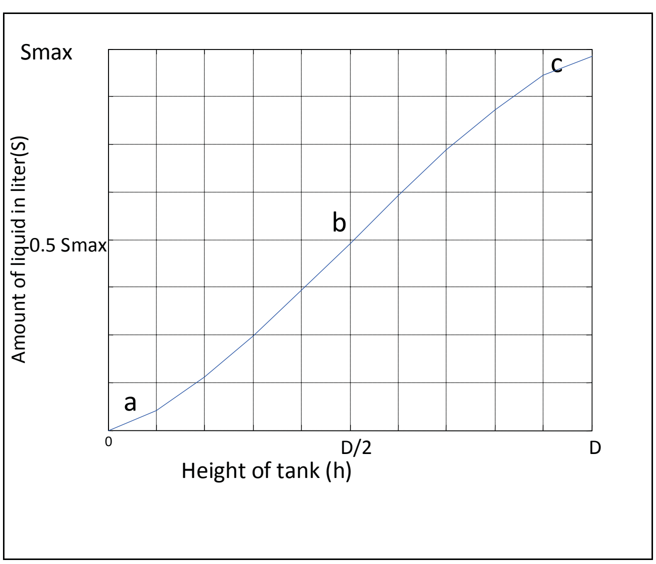

Figure 4.2 : the relationship between S & h in a horizontally mounted tank & this is not linear.

b) Analytical Comparison

When the tank is fully vacant(point a) i.e. h=0 then S=0 for both figures. And when the tank is half filled (point b), h=D/2 & h=L/2 than S=0.5 Smax. When the tank is fully filled (point c) than S=Smax..So that both are satisfying the values since the volume of two tanks are same.

V. Measurements

a) Measurement of Discharge & Entrance

If at any instant the height of the liquid is h2 and after discharge or entrance the height is h1 then the total amount of liquid discharged is

$$\Delta S = S_2 - S_1 \qquad \text{....(5.1)}$$

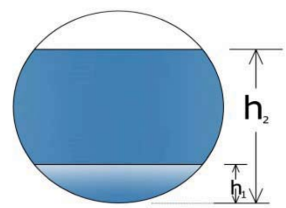

Figure 5.1: Liquid level before & after discharge.

Where S1 is the amount of liquid contained when height is h1 and S2 is the amount of liquid when height is h2 in liter.

Therefore

$$S_1 = 1000L\left[\frac{\pi D^2}{720}cos^{-1}\left(1-\frac{2h_1}{D}\right) - \sqrt{D.h_1 - {h_1}^2}\left(\frac{D}{2}-h_1\right)\right] \text{ And}$$

$$S_2 = 1000L\left[\frac{\pi D^2}{720}cos^{-1}\left(1-\frac{2h_2}{D}\right) - \sqrt{D.h_2 - {h_2}^2}\left(\frac{D}{2}-h_2\right)\right]$$

b) Measurement Of Height (H)

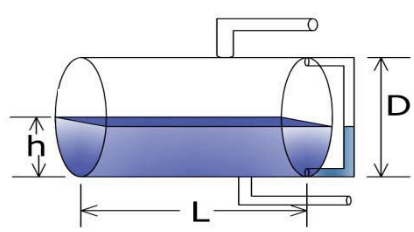

Figure 5.2 : Height measurement

The height of the liquid can be simply measured by using a liquid level indicator which can be made by simple transparent glass or plastic tube. It must be fitted from lowest point to highest point of the diameter vertically. A scale calibrated in meter should be used along with the liquid level indicator and the height will be measured from bottom point of diameter.

VII. Conclusion

A cylindrical tank, whatever it's position, the entire volume is constant irrespective of it's position and also the liquid within it but measurement technique is different for different installation. When it is vertically

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installed measurement problem can be solved using equation (2.1) and when it is horizontally installed can be measured by equation (3.9) as well as (5.1).Thiss is easier then any other method of calculation.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

Surface Water Quality Status of Tunga Left Bank Command, Shimoga & Davangere Dist, Karnataka, India

By Basavaraja Simpi, S.M.Hiremath
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Abstract - Tanks are the major source of irrigation but in recent times due to substantial failure in rainfall the surface water bodies are getting dried up. The ever increase in demand for water resource warrants refinement in the agricultural practices. The Tunga Left Bank Command (TLBC) forms a part of Shimoga and Davanagere districts. Some of the tanks in TLBC are canal-fed and others tanks are of irrigation returns. Consequently, it is important to know the suitability of the water for irrigation. In the present study, about fifteen water samples were collected from the tanks of TLBC and analyzed for physico-chemical parameters viz; pH,EC,TH,TDS ,Ca,Mg,Na,K,CO3,HCO3,PO4,Cl and SO4. The irrigation water quality characteristics, such as Exchangeable Sodium Percentage (ESP) values of canal-fed and unconnected tanks ranges from 0.054 to 2.216 and the values of Sodium Adsorption Ration (SAR) vary from 0.111 to 5.05. Similarly the values of Mg hazard vary from 15.9 to 76.6. The resulted obtained indicate that all the water samples of present study are within the permissible limits for irrigation purposes.

Keywords : Tunga Left Bank Command, SAR, irrigation water quality .

GJSFR-B Classification : For Code : 030301, 050204, 050206

SURFACE WATER QUALITY STATUS OF TUNGA LEFT BANK COMMAND, SHIMOGA DAVANGERE DIST, KARNATAKA, INDIA

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Basavaraja Simpi[α], S.M.Hiremath[Ω]

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Keywords : Tunga Left Bank Command, SAR, irrigation water quality .

I. Introduction

Tank irrigation is one of the oldest and significant sources of irrigation in India and particularly in south India (Palanisamy, 1998). The tanks occupy vital role in the irrigation as well as local ecosystem in the semi-arid and regions of South India. Meanwhile, tank provides multiple uses like source of drinking water for uncountable rural and urban communities and livestock, fish culture, recharge of ground water, control of floods etc., It is well known that agriculture is the single largest user of freshwater resources, using a global average of 70% of all surface water supplies. Except for water lost through evapotranspiration, agricultural water is recycled back to surface water and/or groundwater. However, agriculture is both cause and victim of water pollution. It is a cause through its discharge of pollutants and sediment to surface and/or groundwater, through net loss of soil by poor agricultural practices, and through salinization and water-logging of irrigated land.

It is a victim through use of wastewater and polluted surface and groundwater taken to ensure that agricultural activities do not adversely affect water quality. In view the above knowing the quality of water is most essential in this context, an attempt has been made to understand the tanks water quality for agricultural purpose.

II. Study Area

In the present study an attempt has been made to understand irrigation water quality of tanks in the part of Tunga command. Tunga Left Bank Canal (TLBC) is located in between longitudes 750 31' 00" to 750 40' 00" E and latitudes 130 50' 00" to 140 02' 00" N covering an area of 147.9 Sq.km. The area lies in the part of Shimoga and Davanagere Districts of Karnataka state (Fig 1). The area under the project is in semidry zone, the mean annual rainfall in the study area is 814.90 mm during the period from 1991-2005. The monthly average temperature is 26.220 C. The maximum temperature of 460C was recorded in March 1994 and a minimum of 090 C was recorded in month of December 1994. The average relative humidity of the study area is 63.64%. The relative humidity recorded at in the months of July to October (monsoon) varies from 84% to 54%, while in other months (pre and post monsoons) it varies from 91% to 22%. The study area has an average wind speed of 4.22 km/hr.

There are 26 tanks present in the study area, (Fig 2) out of which four tanks completely extinct. The details of the remaining 17 tanks, in which twelve tanks are canal- fed and other three are irrigation return tanks. Fifteen water samples were collected during the pre-monsoon and post monsoon seasons in the year 2007 and their physico-chemical parameters were studied for the agriculture suitability. About five tanks are got dried-up due to excessive silt deposition and their names are Urmundinakere of Hole Madapura village, Kadada Kattekere of Kadadakatte village, Dodderikere of Dodderi village, Chikkere of Shimoga and Jodikatte of Honnapura village.

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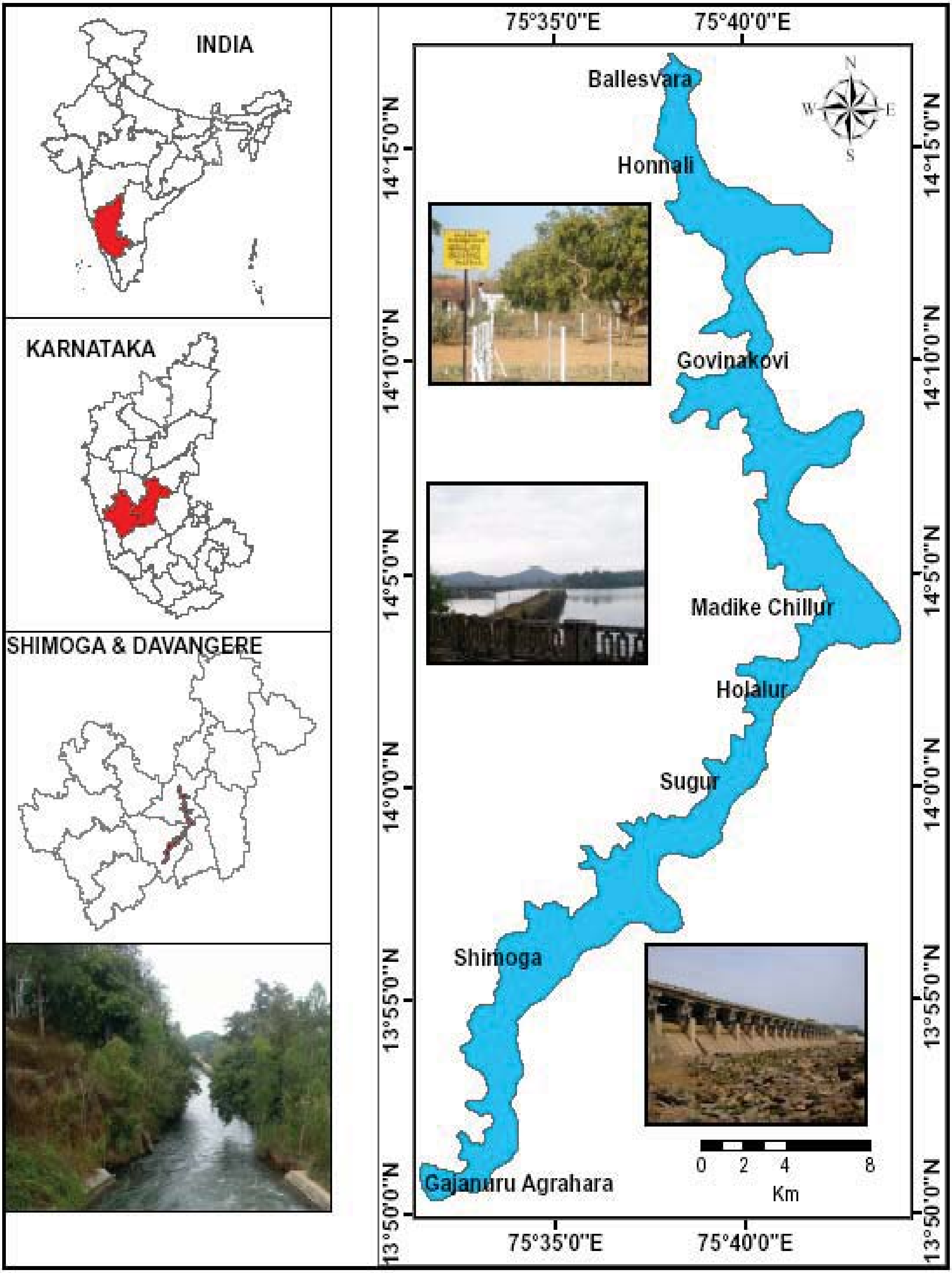

Fig .1 : Location map of the Tunga Left Bank Command area.

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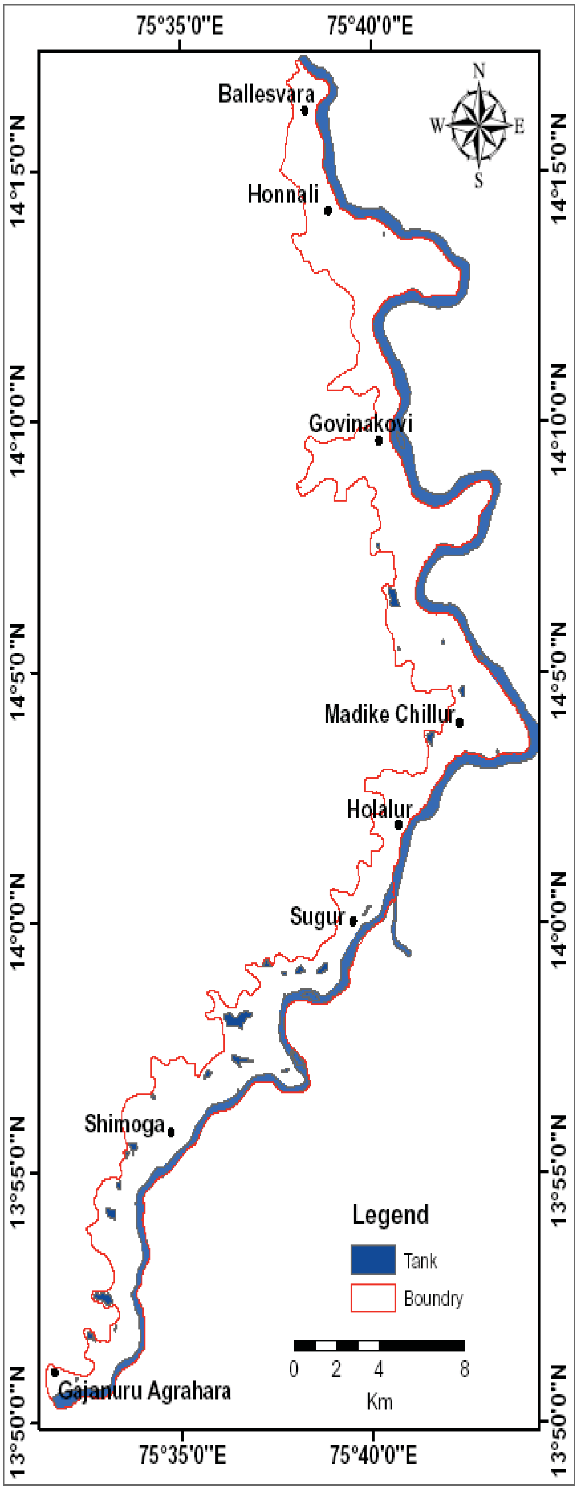

Fig .2 : Location of tanks in TLBC .

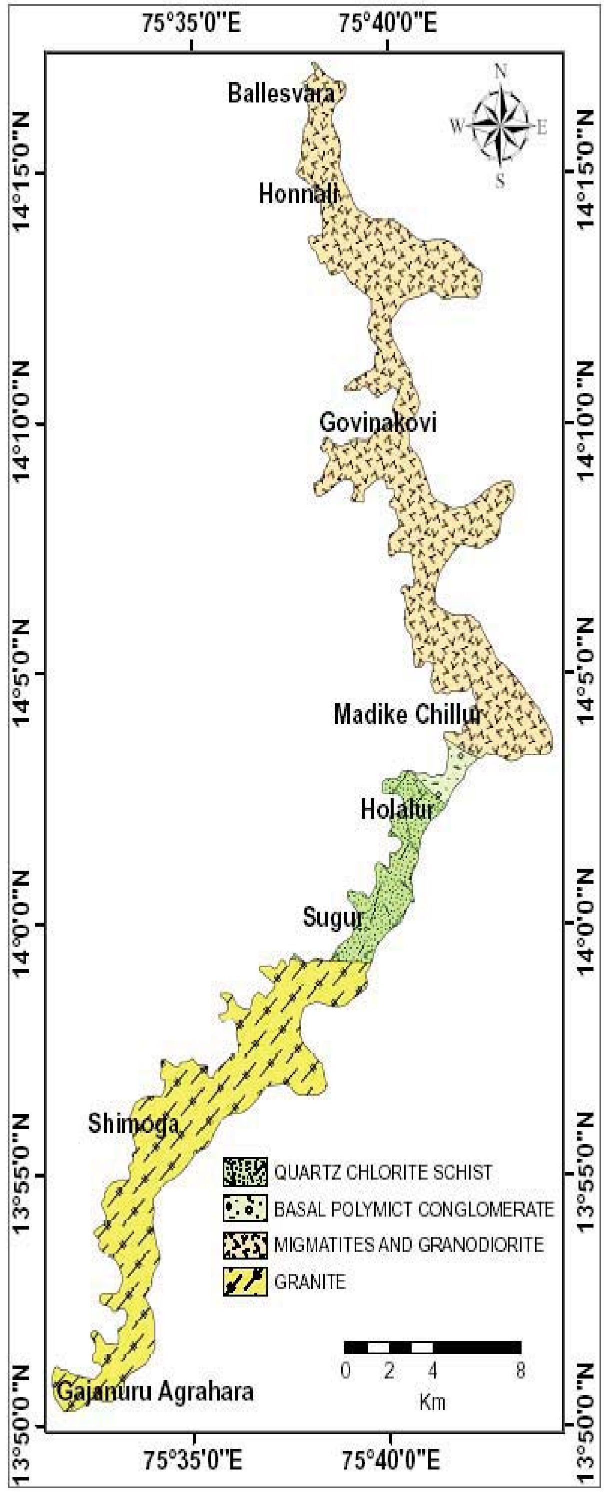

Fig .3 : Geology Map of TLBC.

III. Materials and Methods

The present work is based on fifteen surface water samples, which was collected during pre-monsoon and post-monsoon seasons of 2007. Samples were collected in good quality polyethylene bottles of 1 liter capacity. Sampling was carried out directly without contamination and brought to the laboratory. The pH and electrical conductivity of the water samples were measured in the field using portable water analysis kit.

The cations and anions of the ground water samples were analyzed using standard methods (Trivedy and Goel 1984; APHA, 1980). Total dissolved solids (TDS) were calculated by multiplying 0.6 HCO3, plus other cations and anions. Indian Standard Procedures has been used (Titration method, Atomic Absorption Spectrophotometer (AAS) Thermo M5 Model). Aq.QA version 1.1 software has been used for the water quality evaluation.

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IV. Geology

The study area forms part of Shimoga schist belt, which is one of the important schist in Dharwar Craton. The Shimoga granite-gneiss is regarded as a mantled gneiss domal structure having grano-diorite composition (Syed Ali and Divaker Rao, 1980). This rock is compact gray in color and often jointed and most prominent ones are N250E to S100 E trending joints (Fig 3). The dip of this joint set varies from 500 to almost vertical, geologically TLBC consists essentially of gneisses, basal polymict conglomerate and quartz chlorite schist. Numerous quartz and pegmatite veins traverse all the litho units. In the study area Migmatites and grano-diorites to tonalitic gneisses of Archean age are confined to Northern part. Numerous exposures of migmatites are observed with steep slopes and high degree of weathering is more prominent at places. The general trend of the foliation is NNE-SSW. Presence of mylonitic fabric, δ-porhyroclasts and swearing of foliation indicates that gneisses of the study area have suffered intense deformation.

V. Results and Discussions

The chemical composition of surface water of the study area varies widely. The pH of surface water ranges from 6.8 (Harakere tank) to 8.5 (Bullapura) and 6.6 (Harakere tank) to 8.4 (Sugur) respectively for pre-monsoon and post monsoon seasons. The entire TLBC is neutral to slightly basic in nature (6 to 8) (Table 1). The higher pH values observed in certain samples suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition (Karanth, 1987; Tiwari et al., 2009). TDS, which is measure of that total dissolved solid, varies between 156 to 675.6 and 149 to 625 respectively for pre and post-monsoons. Surface water samples belong to fresh water category (300-500). The water with TDS up to 1000 ml/l is considered suitable for drinking purpose. (WHO, 1984; Pophare and Dewalkar, 2007; Singh and Lawrence, 2007). The water in the study area is well with in the permissible limits for drinking.

a) *Total Hardness (TH)*

Hardness is normally expressed as an equivalent of calcium carbonate (CaCO3) (APHA, 1971). In hard water, the metallic ions may react with soap to produce an insoluble residue. These metallic ions may also react with negatively charged ions to produce solid precipitate when hard water it heated (Freeze and cherry, 1979). Water with hardness less than 100 mg/l calcium carbonate can be deemed desirable for ordinary domestic purposes (Hem, 1985), but only if hardness exceeds 500 mg/l, the water is labeled undesirable for both industrial and domestic uses (WHO, 1971).

In the study area Surface water TH ranges from 88 mg/l (Bullapura) to 307 mg/l (Tegginahalli) (Table 1) and 80 mg/l (Madikechilur) to 399 mg/l (Hosahallikere) respectively for pre and post monsoons.

i. *Irrigation Water quality*

The important parameters which determine the irrigation water quality of the study area discussed below.

b) *Electrical Conductivity (EC)*

It measures the capacity of substance or solution to conduct electric current. The EC of surface water increases with the rise in temperature and varies with the amount of TDS. Conductivity in the surface water samples in the study area ranges from 245.5 μmho's/cm (Bullapura) to 853 μmho's/cm (Tegginahalli) and 205 μmho's/cm (Bullapura) to 847 μmho's/cm (Tegginahalli) respectively for pre-monsoon and post-monsoon (After Wilcox 1948) surface water for the entire TLBC area are in good to medium category.

c) *Sodium Adsorption Ratio (SAR)*

The degree to which irrigation water tends to enter into cation exchange reaction in soil can be indicated by sodium adsorption ratio (USSL, 1954).

It is expressed as

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Ions in the equation are expressed in milli-equivalents per liter, since sodium replaces adsorbed calcium and magnesium in soil, hence excess sodium in groundwater gets adsorbed on soil particles, thus changing soil properties and also reduces soil permeability (Ayers and Bronson, 1975). USDA classification of irrigation water based on SAR, value less than 10 is excellent source of irrigation water for long periods. Water samples in TLBC area ranges from 0.111 to 5.05. USSL classification the surface water in the study area falls in C_1S_1 (20%) moderate, C_2S_1 (60%) good & C_3S_1 (3%) moderate categories (Sharma and Chawla, 1977).

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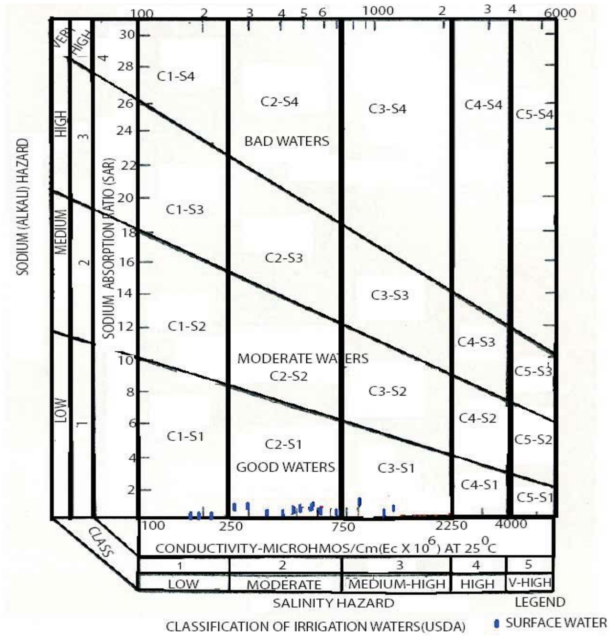

Fig.4 : USSL diagram for Irrigation waters of surface water.

Water Class	No. of pre-monsoon samples	%	No. of Post-monsoon samples	%
C_1S_1	3	20	3	20
C_2S_1	9	60	9	60
C_3S_1	3	20	3	20

Table 1 : USSL Classification of surface water

Toxicity problems occur if certain constituents (ions) in the soil or water are taken up by the plant and accumulate to concentration high enough to cause crop damage to reduce yield in which magnesium is one of the major constituents.

i. *Magnesium Hazard (MH)*

One of the most important qualitative criteria of the Mg content of irrigation waters, calculated by the formula

$$\frac{Mg^{++}}{Ca^{++} + Mg^{++}}$$

Where all the constituents are in meq/l

According to this formula calculation, the MH values of surface water ranges from 15.9 to 76.6, the high Mg ++ absorption effects the soil badly, a harmful effect on soils appears when they above ratio exceed 50.

ii. *Exchangeable Sodium Percentage (ESP)*

In evaluating the suitability of waters for irrigation, it is necessary to consider the extent to which the sodium content of the soil is increased by adsorption of sodium from the water. The property of soils the best correlated with decrease in soil permeability and toxic effects on crops resulting from sodium, the exchangeable sodium percentage (Richards, 1954; Pearson, 1960). The ESP is the amount of exchangeable sodium in the soil expressed as a percentage of the total exchangeable cation capacity. Formula for this is,

$$ESP = \frac{100(-0.0126 + 0.01475 \times SAR)}{1 + (-0.0126 + 0.01475 \times SAR)}$$

ESP values of in TLBC area ranges from 0.054 to 2.216. Therefore, the water samples are classified as 'Extremely sensitive'.

iii. *Residual Sodium Carbonate (RSC)*

Long-term use of irrigation waters may results in high concentrations of bicarbonate, which can severally affect soil permeability. Eaton (1958) gave the concept of residual sodium carbonate and pointed out that development of alkali soils may be expected when irrigation water containing higher (HCO3- +CO3--) than (Ca+++Mg++).

$$\mathbf{RSC = (HCO_3^{-} + CO_3^{--}) - (Ca^{++} + Mg^{++})}$$

Water samples with RSC values greater than 2.5 meq/l are unsuitable for irrigation, if the value is between 1.25 and 2.5 meq/l, the water is of marginal quality, while values less than 1.25 meq/l indicate that the water is probably safe (Wilcox 1958). RSC values of surface water samples of the study area are less than 1.25 meq/l. All the water samples of the study area belong to 'Probably safe class' and is suitable for all types of crops and soils.

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Irrigational Suitability	RSC (meq/l)	Surface water samples
Probably safe	< 1.25	14
Marginal suitable	1.25 – 2.5	-
Unsuitable	>2.5	01

Table 2 : Classification of water samples based on RSC (Richards, Ed., 1954)

Irrigation suitability parameters	Surface water ranges from
Salinity Hazard	Low to medium.
Sodium Absorption Ratio (SAR)	0.111 to 5.05
Magnesium Hazard	15.9 to 76.6
Exchangeable Sodium Ratio (ESR)	0.054 to 2.216

Table 3 : Showing the irrigation suitability parameters

III. Conclusions

The results of geochemical analysis of fifteen surface water samples of the Tunga Left Bank Command indicate that water is neutral to slightly basic in nature (6 to 8). The surface water samples have evaluated for irrigation qualities, the Electrical Conductivity in the surface water samples in the study area falls to good to medium category for irrigation. ESP values of in TLBC area ranges from 0.024 to 2.583, hence the water samples of the TLBC area are classified as 'Extremely sensitive'. Residual Sodium Carbonate (RSC) the water samples of the study area belong to 'Probably safe class' and is suitable for all types of crops and soils. USSL classification the surface water in the study area falls in C1S1 (20%) moderate, C2S1 (60%) good & C3S1 (03%) moderate categories. All the parameters suggest that surface water of the Tunga Left Bank Command area are suitable for irrigation purpose.

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Table 4 : Physico-chemical characteristics of tank water samples

Sl no	Name of the village	Source	Season	PH	EC	Ca	Mg	Na	K	Cl	F	CO_3	HCO_3	NO_3	PO_4	SO_4	TDS
						in ppm											
1	Gajanur Dam	River	Pre	8.1	245	35	4.01	2.6	2.02	20	0.31	Nil	90	4.6	Nil	15	185.6
			post	8.3	215	32	3.86	2.4	1.72	22	0.32	Nil	84	4.32	Nil	5	165.2
2	Virapura(Mulkere)	Tank	Pre	8	310.5	31.2	11.2	8.6	2.09	34	0.28	Nil	105	6.25	Nil	10	225.5
			post	7.7	262	28.8	9.66	7	2.02	30	0.24	Nil	92	5.9	Nil	9.5	195.6
3	Hosahalli kere	Tank	Pre	7.99	325	29.4	16.58	4.8	6.5	32	0.22	Nil	110	2.68	Nil	25	256.4
			post	8.06	306	28.8	15.45	4.5	6.73	28	0.23	Nil	116	2.51	Nil	18.6	225
4	Harakere Tank	Tank	Pre	6.8	480.2	34	17.02	28.2	1.05	49.7	0.25	Nil	60.5	11.4	Nil	105	325
			post	6.6	435	33.6	16.42	26.6	0.94	28	0.3	Nil	144	6.51	Nil	90.2	348
5	Tevara chetannahalli	Tank	Pre	6.92	289.6	25.5	14.5	7.5	1.36	37.5	0.18	Nil	114	7.5	Nil	12	225.6
			post	6.7	260	24	13.52	7.1	1.31	30	0.21	Nil	110	3.48	Nil	15	225
6	Holalur	River	Pre	7.6	475	18.5	36.7	17.2	2.05	70.5	0.16	Nil	142.5	5.86	Nil	25.5	325
			post	8.2	422	17.6	31.88	13.1	1.95	60	0.19	Nil	130	4.77	Nil	10	270
7	Sugur	Canal	Pre	8.5	356.4	32.4	14.58	21.5	1.52	38.5	0.31	Nil	145	5.56	Nil	10.5	275.4
			post	8.4	215.7	30.4	12.56	19.2	0.9	32	0.33	Nil	104	5.03	Nil	34.2	242
8	Bedarahosahalli	Tank	Pre	8.3	756	39.8	7.45	132.4	3.58	62.5	0.18	14	338.5	34.35	Nil	24.2	675.6
			post	8.2	688	38.4	5.8	127	3.44	32	0.2	16	336	29.8	Nil	35.4	625
9	Bullapura	Tank	Pre	8.5	395.6	19.4	32.6	5.35	4.85	56.5	0.18	Nil	135.5	1.98	Nil	10.5	268
			post	8.2	356	16	28.01	5.2	4.72	42	0.19	Nil	80	1.93	0.1	45.3	225
10	Bullapura	Tank	Pre	7.92	224.5	22.57	7.25	7.64	3.57	24.6	0.25	Nil	75.6	3.68	Nil	10.2	156
			post	7.7	205	20.8	6.76	7.1	3.09	22	0.26	Nil	80	3.63	0.09	5	149
11	Madike chilur	Tank	Pre	7.8	409.6	24.8	16.7	11.68	3.45	44.5	0.3	Nil	95.6	8.45	Nil	13.4	220.3
			post	7.5	270	20.8	14.5	10.5	2.86	30	0.38	Nil	96	8.11	Nil	6.5	191
12	Madike chilur	Tank	Pre	8.2	760.2	62.5	29.4	49.7	18.65	95.6	0.4	Nil	289	19.84	Nil	19.8	585.3
			post	7.9	701	56	27.5	47.8	17.57	90	0.59	8	280	17.51	Nil	12	558
13	Malali	Tank	Pre	8.2	366.2	29.5	18.64	10.5	5.02	39.5	0.7	Nil	105	35.8	Nil	12.3	257.6
			post	8.05	335	27.2	17.4	9.1	4.88	28	0.83	Nil	96	34.64	Nil	22.3	241
14	Teginahalli	Tank	Pre	8.2	853	52.4	42.85	69.8	5.2	145.3	0.72	10	256.5	26.5	Nil	15.6	635
			post	7.9	847	49.6	41.54	67.4	4.94	140	0.75	12	250	23.89	Nil	15	610
15	Hirematakere	Tank	Pre	8.06	269	14.4	17.4	6.2	3.55	34	0.26	Nil	48	2.83	0.09	34.3	161
			Post	8.02	295	16.8	19.62	7.52	4.66	35.6	0.25	Nil	98.6	3.05	Nil	15.6	205

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Table 5 : Irrigation water characteristics of Surface Water samples

Sl no	Name of the village	Source	Season	SAR	ESP	MH	TH	TA	RSC (meq/l)	USDA	Water type	Salinity Hazard
1	Gajanur Dam	River	Pre	0.111	0.054	15.9	103.91	73	Nil	C1-S1	Ca - HCO3	LOW
			post	0.107	0.055	16.6	96	69	Nil			
2	Virapura (Mulkere)	Tank	Pre	0.336	0.151	37.2	124	85	Nil	C2-S1	Ca - HCO3	MEDIUM
			post	0.288	0.136	35.6	112	72	Nil			
3	Hosahalli kere	Tank	Pre	0.175	0.074	48.2	142	89	Nil	C2-S1	Ca - HCO3	MEDIUM
			post	0.168	0.072	46.9	136	94	Nil			
4	Harakere Tank	Tank	Pre	0.984	0.396	45.2	155	37	Nil	C2-S1	Ca -So4	MEDIUM
			post	0.939	0.382	44.6	152	76	Nil			
5	Tevara chetannahalli	Tank	Pre	0.293	0.132	48.4	124	73	Nil	C2-S1	Ca-HCO3	MEDIUM
			post	0.287	0.134	48.2	116	62	Nil			
6	Holalur	River	Pre	0.532	0.19	76.6	198	111	Nil	C2-S1	Mg - HCO3	MEDIUM
			post	0.43	0.163	74.9	176	106	Nil			
7	Sugur	Canal	Pre	0.787	0.332	42.6	141	120	Nil	C2-S1	Ca -HCO3	MEDIUM
			post	0.739	0.327	40.5	128	86	Nil			
8	Bedarahosahalli	Tank	Pre	5.05	2.216	23.6	130	290	3.19	C3-S1	Na - HCO3	MEDIUM
			post	5.04	2.308	19.9	120	288	3.35			
9	Bullapura	Tank	Pre	0.172	0.064	73.5	182	112	Nil	C2-S1	Mg - HCO3	MEDIUM
			post	0.181	0.073	74.3	156	65	Nil			
10	Bullapura	Tank	Pre	0.358	0.193	34.6	88	61	Nil	C1-S1	Ca -HCO3	LOW
			post	0.345	0.194	34.9	80	63	Nil			
11	Madike chilur	Tank	Pre	0.444	0.195	52.6	131	76	Nil	C2-S1	Mg - HCO3	MEDIUM
			post	0.432	0.205	53.5	112	74	Nil			
12	Madike chilur	Tank	Pre	1.3	0.39	43.7	278	236	Nil	C3-S1	Ca -HCO3	MEDIUM
			post	1.31	0.411	44.7	254	231	Nil			
13	Malali	Tank	Pre	0.372	0.152	51	150	86	Nil	C2-S1	Mg - HCO3	MEDIUM
			post	0.335	0.142	51.3	140	78	Nil			
14	Tegginahalli	Tank	Pre	1.73	0.494	57.4	307	218	Nil	C3-S1	Mg - HCO3	HIGH
			post	1.71	0.497	58	295	210	Nil			
15	Hirematakere	Tank	Pre	0.295	0.133	65.8	124	79	Nil	C1-S1	Mg - HCO3	MEDIUM
			Post	0.26	0.125	66.6	108	39	Nil			

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

Construction of a Summation Formula Interlaced With Recurrence Relation and Hypergeometric Function

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GJSFR-A Classification : FOR Code: 010405

CONSTRUCTION OF A SUMMATION FORMULA INTERLACED WITH RECURRENCE RELATION AND HYPERGEOMETRIC FUNCTION

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Construction of a Summation Formula Interlaced With Recurrence Relation and Hypergeometric Function

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Abstract - In this paper we construct a summation formula, interlaced with recurrence relation and hypergeometric function.
Keywords : Contiguous relation, Generalized Gaussian Hypergeometric function, Recurrence relation.

I. Introduction

Generalized Gaussian hypergeometric function of one variable is defined as

$$ {}_AF_B\left[\begin{matrix} a_1, a_2, \cdots, a_A & ; \\ & & z \\ b_1, b_2, \cdots, b_B & ; \end{matrix}\right] = \sum_{k=0}^{\infty} \frac{(a_1)_k (a_2)_k \cdots (a_A)_k z^k}{(b_1)_k (b_2)_k \cdots (b_B)_k k!} $$

or

$$ {}_AF_B\left[\begin{matrix} (a_A) & ; \\ & & z \\ (b_B) & ; \end{matrix}\right] \equiv {}_AF_B\left[\begin{matrix} (a_j)_{j=1}^A & ; \\ & & z \\ (b_j)_{j=1}^B & ; \end{matrix}\right] = \sum_{k=0}^{\infty} \frac{((a_A))_k z^k}{((b_B))_k k!} \tag{1.1} $$

where the parameters b1, b2, · · · , b_B are neither zero nor negative integers and A, B are non-negative integers and $|z| = 1$.

Contiguous Relation is given by the following expression

$$ (a-b)\ {}_2F_1\left[\begin{matrix} a, & b\ ; \\ c & ; \end{matrix}\ z\right] = a\ {}_2F_1\left[\begin{matrix} a+1, & b & ; \\ c & & ; \end{matrix}\ z\right] - b\ {}_2F_1\left[\begin{matrix} a, & b+1 & ; \\ c\ ; \end{matrix}\ z\right] \tag{1.2} $$

Gauss second summation theorem [Prud., 491(7.3.7.5)]

$$ {}_2F_1\left[\begin{matrix} a, & b & ; \\ \frac{a+b+1}{2} & & ; \end{matrix}\ \frac{1}{2}\right] = \frac{\Gamma(\frac{a+b+1}{2})\ \Gamma(\frac{1}{2})}{\Gamma(\frac{a+1}{2})\ \Gamma(\frac{b+1}{2})} \tag{1.3} $$

$$ = \frac{2^{(b-1)}\ \Gamma(\frac{b}{2})\ \Gamma(\frac{a+b+1}{2})}{\Gamma(b)\ \Gamma(\frac{a+1}{2})} \tag{1.4} $$

Recurrence relation is defined as following

$$ \Gamma(\zeta+1) = \zeta\ \Gamma(\zeta) \tag{1.5} $$

II. Main Result of The Summation Formula

$$ {}_2F_1\left[\begin{matrix} a, & b & ; \\ \frac{a+b+43}{2} & & ; \end{matrix}\ \frac{1}{2}\right] = \frac{2^b\ \Gamma(\frac{a+b+43}{2})}{(a-b)\ \Gamma(b)} \times $$

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$$\times\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a+1}{2})}\left\{\frac{1048576a(319830986772877770815625-793076329745158961502000a)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+\right.\right.$$

$$+\frac{1048576a(787995759739909824183150a^2-440604294676004639627280a^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(159940198124792648875341a^4-40757108535689214225600a^5)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(7652296057856603272680a^6-1092926016966998436160a^7)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(121344378918220620226a^8-10627666045365252000a^9)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(741138328282003860a^{10}-41357055277206240a^{11}+1848366089479026a^{12})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-65952604619200a^{13}+1864098465640a^{14}-41162809920a^{15})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(694529781a^{16}-8641200a^{17}+74670a^{18}-400a^{19}+a^{20})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-298677783336611201523000b+289237631786553112186230 0ab)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-1239559320811518856051560a^2b+1434781934695498765973076a^3b)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-287187680273501906329824a^4b+124624420367497369988976a^5b)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-14488222605675140113440a^6b+3195527370095701704592a^7b)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-234077921187817903248a^8b+29922450377139075912a^9b)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{1048576a(-1424245102551276720a^{10}b+112269054410294808a^{11}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-3464317208238432a^{12}b+172047191152048a^{13}b-3314002480800a^{14}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(102253546704a^{15}b-1113365496a^{16}b+20032764a^{17}b-93480a^{18}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(820a^{19}b+170534691881331890415975 0b^2-3734534896524128790576 00ab^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(32470132913377349218564 86a^2b^2-48770749435549279846579 2a^3b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(578766813512700259152504a^4b^2-55569144425621557882368a^5b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(2526935149845341958952 8a^6b^2-160201883504659442867 2a^7b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(37019565188069774882 0a^8b^2-15689445582764260736a^9b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(208743996995367147 6a^{10}b^2-58468813304229120a^{11}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(4750821740163928a^{12}b^2-84242492063744a^{13}b^2+4257347456440a^{14}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-43147177216a^{15}b^2+1329411798a^{16}b^2-5833152a^{17}b^2+101270a^{18}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(2412671695630523630881 20b^3+23906796779282375613257 64ab^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-1183767561677569555589 76a^2b^3+10697234239741727928544 32a^3b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{1048576a(-7341230297644069427286 4a^4b^3+857085039429788333030 88a^5b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-448676220070252993145 6a^6b^3+203216094474690100835 2a^7b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-75567875027920642224a^8b^3+174358264462891549 04a^9b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-443173273806431168a^{10}b^3+58688234696618592a^{11}b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-965145307715680a^{12}b^3+77482715861936a^{13}b^3-739925609280a^{14}b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(36486689824a^{15}b^3-152877192a^{16}b^3+4496388a^{17}b^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(4945962011920890900348 69b^4+159282919505046680273088ab^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(85758712960417497618415 2a^2b^4-142652555051082120520 32a^3b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(141617455571638054961004a^4b^4-50694435332574463713 92a^5b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(571682411845268557943 2a^6b^4-173659393928659459392a^7b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(7640830172546801430 2a^8b^4-1705097951760448960a^9b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(3829811847864322 32a^{10}b^4-5748183402410176a^{11}b^4+739094390507564a^{12}b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-6601942737600a^{13}b^4+510864616600a^{14}b^4-2038362560a^{15}b^4)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}$$

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$$+\frac{1048576a(95548245a^{16}b^{4}+55034701912518351591456b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(285611154005039511961584ab^{5}+31537703278468962890016a^{2}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(118731229184286059092336a^{3}b^{5}-774244540786354732640a^{4}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(8798607203538482909488a^{5}b^{5}-176035164115167701344a^{6}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(189881872539940117680a^{7}b^{5}-3418043416078880160a^{8}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(1440342352090916560a^{9}b^{5}-18912462302333600a^{10}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(4072058462779216a^{11}b^{5}-33224290546720a^{12}b^{5}+4082173819920a^{13}b^{5})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-15287719200a^{14}b^{5}+1121099408a^{15}b^{5}+30696135069207383810376b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(17710187496390694640512ab^{6}+49579959836428198057816a^{2}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(2613497180326239520768a^{3}b^{6}+7581683894366315268808a^{4}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-20429562257255831680a^{5}b^{6}+278361738507093353112a^{6}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-3197371717288027136a^{7}b^{6}+3279322945283002904a^{8}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(-34316197434879360a^{9}b^{6}+13725332250654024a^{10}b^{6}-97498766124032a^{11}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{1048576a(19915668515288a^{12}b^{6}-68049950080a^{13}b^{6}+7898654920a^{14}b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(234399215858442058608 0b^{7}+938719663373350241070 4ab^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(1847060337580314435904a^{2}b^{7}+3622196907545420899552a^{3}b^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(1038509014586316004 16a^{4}b^{7}+244302154198631848176a^{5}b^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-2657557546894398 72a^{6}b^{7}+4641765626221435712a^{7}b^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-301700184938243 52a^{8}b^{7}+29303554370067120a^{9}b^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-164092203484352a^{10}b^{7}+61905754398176a^{11}b^{7}-183248794144a^{12}b^{7})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(35240152720a^{13}b^{7}+6078300429274278648 02b^{8}+4347682528837940876 48ab^{8})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(914874909079607142212a^{2}b^{8}+840328732982052508 48a^{3}b^{8})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(127613060239609321806a^{4}b^{8}+20969694717364947 84a^{5}b^{8})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(4127078539954327672a^{6}b^{8}-1603091087193024a^{7}b^{8}+40409776620754398a^{8}b^{8})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(-137325965531040a^{9}b^{8}+125931280354308a^{10}b^{8}-291042202464a^{11}b^{8})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(103077446706a^{12}b^{8}+3175662303396343051 2b^{9}+1091146309132723381 20ab^{9})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{1048576a(2660247534892670465 6a^{2}b^{9}+3856277005534964639 2a^{3}b^{9})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(1853448692351782240a^{4}b^{9}+2296049171414267984a^{5}b^{9})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(21574255542167328a^{6}b^{9}+36273797262928368a^{7}b^{9}-3510377442000a^{8}b^{9})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(170253305937000a^{9}b^{9}-234025162800a^{10}b^{9}+202112640600a^{11}b^{9})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(457016885682895933 2b^{10}+358945913184026854 4ab^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(6342459520540084084a^{2}b^{10}+706602948189149440a^{3}b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(784258761123523400a^{4}b^{10}+20270000707756800a^{5}b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(211365676411890 00a^{6}b^{10}+105592153455360a^{7}b^{10}+15393005083170 0a^{8}b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(269128937220a^{10}b^{10}+1627452687248388 00b^{11}+501669242834717880ab^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(1320098304176046 72a^{2}b^{11}+158237225767248992a^{3}b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(87795417535134 40a^{4}b^{11}+7885294944326800a^{5}b^{11}+103643929433408a^{6}b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(92873098607328a^{7}b^{11}+191475133200a^{8}b^{11}+244662670200a^{9}b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{1048576a(14048772429629730b^{12}+112916503203504 00ab^{12})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{1048576a(17587079040893752a^2b^{12}+2020184418709184a^3b^{12})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(1832773289716460a^4b^{12}+49222930655808a^5b^{12}+36992002900216a^6b^{12})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(194028134976a^7b^{12}+151584480450a^8b^{12}+333885390472608b^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(943016570640688ab^{13}+243072775316000a^2b^{13}+253385470855664a^3b^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(13093578701280a^4b^{13}+9525291762448a^5b^{13}+98672427616a^6b^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(63432274896a^7b^{13}+17769956078408b^{14}+13714881356416ab^{14})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(19271530266616a^2b^{14}+1963099942400a^3b^{14}+1532005860600a^4b^{14})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(29164264320a^5b^{14}+17620076360a^6b^{14}+267913306080b^{15})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(698946258192ab^{15}+156953917120a^2b^{15}+145742923040a^3b^{15})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(5095906400a^4b^{15}+3159461968a^5b^{15}+8671926933b^{16}+5869933264ab^{16})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(7503722174a^2b^{16}+509590640a^3b^{16}+350343565a^4b^{16}+742044424b^{17})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(178275708ab^{17}+26978328a^2b^{17}+22481940a^3b^{17}+1360134b^{18})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{1048576a(648128ab^{18}+749398a^2b^{18}+4920b^{19}+10660ab^{19}+41b^{20})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{1048576b(319830986772877770815625 - 298677783336611201523000a)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(170534691881331890415975 0a^2 + 241267169563052363088120a^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(49459620119208909003486 9a^4 + 55034701912518351591456a^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(30696135069207383810376a^6 + 2343992158584420586080a^7)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(607830042927427864802a^8 + 31756623033963430512a^9)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(4570168856828959332a^{10} + 162745268724838800a^{11} + 14048772429629730a^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(333885390472608a^{13} + 17769956078408a^{14} + 267913306080a^{15})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(8671926933a^{16} + 74204424a^{17} + 1360134a^{18} + 4920a^19 + 41a^{20})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-793076329745158961502000b + 2892376317865531121862300ab)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-3734534896524128790576 00a^2b + 2390679677928237561325764a^3b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1592829195050466802730 88a^4b + 285611154005039511961584a^5b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(177101874963906946405 12a^6b + 9387196633733502410704a^7b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(434768252883794087648a^8b + 10911463091327233812 0a^9b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(3589459131840268544a^{10}b+501669242834717880a^{11}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(11291650320350400a^{12}b+943016570640688a^{13}b+13714881356416a^{14}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(698946258192a^{15}b+5869933264a^{16}b+178275708a^{17}b+648128a^{18}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(10660a^{19}b+787995759739909824183150b^{2}-1239559320811518856051560ab^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(3247013291337734921856486a^{2}b^{2}-118376756167756955558976a^{3}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(857587129604174976184152a^{4}b^{2}+31537703278468962890016a^{5}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(49579959836428198057816a^{6}b^{2}+1847060337580314435904a^{7}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(914874909079607142212a^{8}b^{2}+26602475348926704656a^{9}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(6342459520540084084a^{10}b^{2}+132009830417604672a^{11}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(17587079040893752a^{12}b^{2}+243072775316000a^{13}b^{2}+19271530266616a^{14}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(156953917120a^{15}b^{2}+7503722174a^{16}b^{2}+26978328a^{17}b^{2}+749398a^{18}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-440604294676004639627280b^{3}+1434781934695498765973076ab^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-487707494355492798465792a^{2}b^{3}+1069723423974172792854432a^{3}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(-1426525550510821205203 2a^4b^3+1187312291842860590923 36a^5b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(261349718032623952076 8a^6b^3+362219690754542089955 2a^7b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(84032873298205250848a^8b^3+38562770055349646392a^9b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(7066029481891494 40a^{10}b^3+1582372257672489 92a^{11}b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(2020184418709184a^{12}b^3+253385470855664a^{13}b^3+19630999424 00a^{14}b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(145742923040a^{15}b^3+509590640a^{16}b^3+22481940a^{17}b^3)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1599401981247926488753 41b^4-2871876802735019063298 24ab^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(5787668135127002591525 04a^2b^4-7341230297644069427286 4a^3b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1416174555716380549610 04a^4b^4-7742445407863547326 40a^5b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(758168389436631526880 8a^6b^4+103850901458631600416a^7b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(12761306023960932180 6a^8b^4+18534486923517822 40a^9b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(784258761123523400a^{10}b^4+8779541753513440a^{11}b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(18327732897164 60a^{12}b^4+13093578701280a^{13}b^4+1532005860600a^{14}b^4)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(5095906400a^{15}b^4+350343565a^{16}b^4-40757108535689214225600b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(124624420367497369988976ab^5-55569144425621557882368a^2b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(85708503942978833303088a^3b^5-5069443533257446371392a^4b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(8798607203538482909488a^5b^5-20429562257255831680a^6b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(244302154198631848176a^7b^5+2096969471736494784a^8b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(2296049171414267984a^9b^5+20270000707756800a^{10}b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(7885294944326800a^{11}b^5+49222930655808a^{12}b^5+9525291762448a^{13}b^5)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(29164264320a^{14}b^5+3159461968a^{15}b^5+7652296057856603272680b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(29164264320a^{14}b^5+3159461968a^{15}b^5+7652296057856603272680b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-14488222605675140113440ab^6+25269351498453419589528a^2b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-4486762200702529931456a^3b^6+5716824118452685579432a^4b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-176035164115167701344a^5b^6+278361738507093353112a^6b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-265755754689439872a^7b^6+4127078539954327672a^8b^6)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(21574255542167328a^{9}b^{6}+2113656764118900 0a^{10}b^{6}+103643929433408a^{11}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(36992002900216a^{12}b^{6}+98672427616a^{13}b^{6}+17620076360a^{14}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-109292601696699843616 0b^{7}+3195527370095701704592ab^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-1602018835046594428672a^{2}b^{7}+2032160944746901008352a^{3}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-1736593939286594593 92a^{4}b^{7}+1898818725399401176 80a^{5}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-319737171728802713 6a^{6}b^{7}+464176562622143571 2a^{7}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-1603091087193024a^{8}b^{7}+36273797262928368a^{9}b^{7}+105592153455360a^{10}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(92873098607328a^{11}b^{7}+194028134976a^{12}b^{7}+63432274896a^{13}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1213443789182206202 26b^{8}-2340779211878179032 48ab^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(3701956518806977488 20a^{2}b^{8}-7556787502792064222 4a^{3}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(7640830172546801430 2a^{4}b^{8}-3418043416078880160a^{5}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(327932294528300290 4a^{6}b^{8}-30170018493824352a^{7}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(40409776620754398a^{8}b^{8}-3510377442000a^{9}b^{8}+153930050831700a^{10}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(191475133200a^{11}b^{8}+151584480450a^{12}b^{8}-106276660453652520000b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(299224503771390759120ab^{9}-156894455827642607360a^{2}b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(174358264462891549040a^{3}b^{9}-17050979517604489600a^{4}b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1440342352090916560a^{5}b^{9}-343161974348793600a^{6}b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(29303554370067120a^{7}b^{9}-137325965531040a^{8}b^{9}+170253305937000a^{9}b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(244662670200a^{11}b^{9}+7411383282820038600b^{10}-14242451025512767200ab^{10})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(20874399699536714760a^{2}b^{10}-4431732738064311680a^{3}b^{10})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(382981184786432232a^{4}b^{10}-18912462302333600a^{5}b^{10})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(13725332250654024a^{6}b^{10}-164092203484352a^{7}b^{10}+1259312803543080a^{8}b^{10})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-234025162800a^{9}b^{10}+269128937220a^{10}b^{10}-4135705527720624000b^{11})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(11226905441029480800ab^{11}-5846881330422912000a^{2}b^{11})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(586882346966185920a^{3}b^{11}-57481834024101760a^{4}b^{11})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(4072058462779216a^{5}b^{11}-97498766124032a^{6}b^{11}+61905754398176a^{7}b^{11})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(-291042202464a^8b^{11}+202112640600a^9b^{11}+1848366089479026b^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-3464317208238432ab^{12}+4750821740163928a^2b^{12}-965145307715680a^3b^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(739094390507564a^4b^{12}-33224290546720a^5b^{12}+19915668515288a^6b^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-183248794144a^7b^{12}+103077446706a^8b^{12}-65952604619200b^{13})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(172047191152048ab^{13}-84242492063744a^2b^{13}+77482715861936a^3b^{13})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-6601942737600a^4b^{13}+4082173819920a^5b^{13}-68049950080a^6b^{13})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(35240152720a^7b^{13}+1864098465640b^{14}-3314002480800ab^{14})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(4257347456440a^2b^{14}-739925609280a^3b^{14}+510864616600a^4b^{14})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-15287719200a^5b^{14}+7898654920a^6b^{14}-41162809920b^{15})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(102253546704ab^{15}-43147177216a^2b^{15}+36486689824a^3b^{15})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(-2038362560a^4b^{15}+1121099408a^5b^{15}+694529781b^{16}-1113365496ab^{16})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(1329411798a^2b^{16}-152877192a^3b^{16}+95548245a^4b^{16}-8641200b^{17})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{1048576b(20032764ab^{17-5}833152a^2b^{17}+4496388a^3b^{17}+74670b^{18}-93480ab^{18})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{1048576b(101270a^2b^{18}-400b^{19}+820ab^{19}+b^{20})}{\left[\prod_{\Phi=1}^{21}\{a-b-(2\Phi-1)\}\right]\left[\prod_{\Psi=1}^{20}\{a-b+(2\Psi-1)\}\right]}\Bigg\}-$$

$$-\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a}{2})}\Bigg\{\frac{2097152(31983098677287770815625+2986777833366112015230000a)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(17053469188133189041597 50a^2-24126716956305236308812 0a^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(4945962011920890900348 69a^4-5503470191251835159145 6a^5)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(306961350692073838103 76a^6-234399215858442058608 0a^7)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(60783004292742786480 2a^8-31756623033963430512a^9)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(457016885682895933 2a^{10}-162745268724838800a^{11}+1404877242962973 0a^{12})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-333885390472608a^{13}+17769956078408a^{14}-267913306080a^{15})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(8671926933a^{16}-74204424a^{17}+1360134a^{18}-4920a^{19}+41a^{20})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(7930763297451589615020 00b+28923763178655311218623 00ab)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(3734534896524128790576 00a^2b+2390679677928237561325 764a^3b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-1592829195050466802730 88a^4b+2856111540050395119615 84a^5b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-177101874963906946405 12a^6b+938719663373350241070 4a^7b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{2097152(-4347682528837940876480a^8b+1091146309132723381200a^9b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-358945913184026854 4a^{10}b+50166924283471788 0a^{11}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-11291650320350400a^{12}b+943016570640688a^{13}b-13714881356416a^{14}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(698946258192a^{15}b-5869933264a^{16}b+178275708a^{17}b-648128a^{18}b)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(10660a^{19}b+78799575973990982418315 0b^2+123955932081151885605156 0ab^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(324701329133773492185648 6a^2b^2+118376756167756955558976a^3b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(857587129604174976184152a^4b^2-31537703278468962890016a^5b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(4957995983642819805781 6a^6b^2-1847060337580314435904a^7b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(91487490907960714221 2a^8b^2-266024753489267046 56a^9b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(634245952054008408 4a^{10}b^2-132009830417604672a^{11}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(17587079040893752a^{12}b^2-243072775316000a^{13}b^2+19271530266616a^{14}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-156953917120a^{15}b^2+7503722174a^{16}b^2-26978328a^{17}b^2+749398a^{18}b^2)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(44060429467600463962728 0b^3+143478193469549876597307 6ab^3)}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{2097152(48770749435549279846579 2a^2b^3+10697234239741727928544 32a^3b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(1426525550510821205203 2a^4b^3+11873122918428605909233 6a^5b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(-261349718032623952076 8a^6b^3+3622196907545420899552a^7b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(-840328732982052508 48a^8b^3+38562770055349646392a^9b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(-7066029481891494 40a^{10}b^3+1582372257672489 92a^{11}b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(-2020184418709184a^{12}b^3+253385470855664a^{13}b^3-1963099942400a^{14}b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(145742923040a^{15}b^3-509590640a^{16}b^3+22481940a^{17}b^3)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(159940198124792648875341b^4+28718768027350190632982 4ab^4)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(57876681351270025915250 4a^2b^4+73412302976440694272864a^3b^4)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(14161745557163805496100 4a^4b^4+7742445407863547326 40a^5b^4)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(75816838943663152688 08a^6b^4-1038509014586316004 16a^7b^4)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(127613060239609321806a^8b^4-18534486923517822 40a^9b^4)}{\left[\prod^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(7842587611235234 00a^{10}b^4-877954175351344 0a^{11}b^4+183277328971646 0a^{12}b^4)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{2097152(-13093578701280a^{13}b^{4}+1532005860600a^{14}b^{4}-5095906400a^{15}b^{4})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(350343565a^{16}b^{4}+4075710853568921422560 0b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(1246244203674973699889 76ab^{5}+5556914442562155788236 8a^{2}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(857085039429788333030 88a^{3}b^{5}+506944353325744637139 2a^{4}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(879860720353848290948 8a^{5}b^{5}+204295622572558316 80a^{6}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(24430215419863184 8176a^{7}b^{5}-20969694717364947 84a^{8}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(2296049171414267984a^{9}b^{5}-202700007077568 00a^{10}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(7885294944326800a^{11}b^{5}-49222930655808a^{12}b^{5}+9525291762448a^{13}b^{5})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(-29164264320a^{14}b^{5}+3159461968a^{15}b^{5}+7652296057856603272680b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(1448822260567514011344 0ab^{6}+2526935149845341958952 8a^{2}b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(448676220070252993145 6a^{3}b^{6}+571682411845268557943 2a^{4}b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(176035164115167701344a^{5}b^{6}+27836173850709335311 2a^{6}b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(2657557546894398 72a^{7}b^{6}+4127078539954327672a^{8}b^{6})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

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$$+\frac{2097152(-21574255542167328a^{9}b^{6}+21136567641189000a^{10}b^{6}-10364392943340 8a^{11}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(36992002900216a^{12}b^{6}-98672427616a^{13}b^{6}+17620076360a^{14}b^{6})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(1092926016966998436160b^{7}+3195527370095701704592ab^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(1602018835046594428672a^{2}b^{7}+2032160944746901008352a^{3}b^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(1736593939286594593920a^{4}b^{7}+189881872539940117680a^{5}b^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(31973717172880271360a^{6}b^{7}+464176562622143571 2a^{7}b^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(16030910871930 24a^{8}b^{7}+36273797262928368a^{9}b^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(-105592153455360a^{10}b^{7}+92873098607328a^{11}b^{7}-194028134976a^{12}b^{7})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(63432274896a^{13}b^{7}+121344378918220620226b^{8}+234077921187817903248ab^{8})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(370195651880697748820a^{2}b^{8}+755678750279206422 24a^{3}b^{8})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(76408301725468014302a^{4}b^{8}+34180434160788801 60a^{5}b^{8})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(327932294528300290 4a^{6}b^{8}+30170018493824352a^{7}b^{8}+404097766207543 98a^{8}b^{8})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(3510377442000a^{9}b^{8}+153930050831700a^{10}b^{8}-191475133200a^{11}b^{8})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{2097152(151584480450a^12b^8+1062766604536525200 0b^9+2992245037713907591 2ab^9)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(15689445582764260736a^2b^9+17435826446289154904a^3b^9)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(1705097951760448960a^4b^9+1440342352090916560a^5b^9)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(34316197434879360a^6b^9+29303554370067120a^7b^9+137325965531040a^8b^9)}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(170253305937000a^9b^9+244662670200a^11b^9+7411383282820038 60b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(14242451025512767 20ab^{10}+20874399699536714 76a^2b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(443173273806431168a^3b^{10}+382981184786432232a^4b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(18912462302333600a^5b^{10}+13725332250654024a^6b^{10}+164092203484352a^7b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(125931280354308a^8b^{10}+234025162800a^9b^{10}+269128937220a^{10}b^{10})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(413570552772062 40b^{11}+112269054410294808ab^{11}+58468813304229120a^2b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(58688234696618592a^3b^{11}+5748183402410176a^4b^{11}+4072058462779216a^5b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(97498766124032a^6b^{11}+61905754398176a^7b^{11}+291042202464a^8b^{11})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

$$+\frac{2097152(202112640600a^9b^{11}+1848366089479026b^{12}+3464317208238432ab^{12})}{\left[\prod_{\Theta=1}^{20}\left\{a-b-(2\Theta-1)\right\}\right]\left[\prod_{\Lambda=1}^{21}\left\{a-b+(2\Lambda-1)\right\}\right]}+$$

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$$+\frac{2097152(4750821740163928a^2b^{12}+965145307715680a^3b^{12}+739094390507564a^4b^{12})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(33224290546720a^5b^{12}+19915668515288a^6b^{12}+183248794144a^7b^{12})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(103077446706a^8b^{12}+659526046192006b^{13}+172047191152048ab^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(84242492063744a^2b^{13}+77482715861936a^3b^{13}+6601942737600a^4b^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(4082173819920a^5b^{13}+68049950080a^6b^{13}+35240152720a^7b^{13})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(1864098465640b^{14}+3314002480800ab^{14}+4257347456440a^2b^{14})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(739925609280a^3b^{14}+510864616600a^4b^{14}+15287719200a^5b^{14})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(7898654920a^6b^{14}+41162809920b^{15}+102253546704ab^{15}+43147177216a^2b^{15})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(36486689824a^3b^{15}+2038362560a^4b^{15}+1121099408a^5b^{15}+694529781b^{16})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(1113365496ab^{16}+1329411798a^2b^{16}+152877192a^3b^{16}+95548245a^4b^{16})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(8641200b^{17}+20032764ab^{17}+5833152a^2b^{17}+4496388a^3b^{17}+74670b^{18})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(93480ab^{18}+101270a^2b^{18}+400b^{19}+820ab^{19}+b^{20})}{\left[\prod_{\Theta=1}^{20}\{a-b-(2\Theta-1)\}\right]\left[\prod_{\Lambda=1}^{21}\{a-b+(2\Lambda-1)\}\right]}+$$

$$+\frac{2097152(3198309867728777708156025+7930763297451589615020000a)}{\left[\prod^{21}\{a-b-(2\Phi-1)\}\right]\left[\prod^{20}\{a-b+(2\Psi-1)\}\right]}+$$

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$$+\frac{2097152(787995759739909824183150a^{2}+440604294676004639627280a^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(159940198124792648875341a^{4}+40757108535689214225600a^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(7652296057856603272680a^{6}+1092926016966998436160a^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(121344378918220620226a^{8}+10627666045365252000a^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(741138328282003860a^{10}+41357055277206240a^{11}+1848366089479026a^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(65952604619200a^{13}+1864098465640a^{14}+41162809920a^{15}+694529781a^{16})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(8641200a^{17}+74670a^{18}+400a^{19}+a^{20}+298677783336611201523000b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(2892376317865531121862300ab+1239559320811518856051560a^{2}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(143478193469549876597307 6a^{3}b+287187680273501906329824a^{4}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(12462442036749736998897 6a^{5}b+14488222605675140113440a^{6}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(319552737009570170459 2a^{7}b+234077921187817903248a^{8}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(29922450377139075912a^{9}b+1424245102551276720a^{10}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(112269054410294808a^{11}b+3464317208238432a^{12}b+172047191152048a^{13}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{2097152(3314002480800a^{14}b+102253546704a^{15}b+1113365496a^{16}b+20032764a^{17}b)}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(93480a^{18}b+820a^{19}b+1705346918813318904159750b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(3734534896524128790576000ab^{2}+3247013291337734921856486a^{2}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4877074943554927984657920a^{3}b^{2}+5787668135127002591525040a^{4}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(5556914442562155788236800a^{5}b^{2}+2526935149845341958952800a^{6}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1602018835046594428672a^{7}b^{2}+3701956518806977488200a^{8}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(15689445582764260736a^{9}b^{2}+2087439969953671476a^{10}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(58468813304229120a^{11}b^{2}+4750821740163928a^{12}b^{2}+84242492063744a^{13}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4257347456440a^{14}b^{2}+43147177216a^{15}b^{2}+1329411798a^{16}b^{2}+5833152a^{17}b^{2})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(101270a^{18}b^{2}-2412671695630523630881200b^{3}+2390679677928237561325764ab^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1183767561677569555589760a^{2}b^{3}+1069723423974172792854432a^{3}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(7341230297644069427286400a^{4}b^{3}+8570850394297883330308800a^{5}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(448676220070252993145600a^{6}b^{3}+203216094474690100835200a^{7}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{2097152(75567875027920642224a^{8}b^{3}+17435826446289154904a^{9}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(443173273806431168a^{10}b^{3}+58688234696618592a^{11}b^{3}+965145307715680a^{12}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(77482715861936a^{13}b^{3}+739925609280a^{14}b^{3}+36486689824a^{15}b^{3})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(152877192a^{16}b^{3}+4496388a^{17}b^{3}+4945962011920890900034869b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-159282919505046680273088ab^{4}+857587129604174976184152a^{2}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(14265255505108212052032a^{3}b^{4}+141617455571638054961004a^{4}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(5069443533257446371392a^{5}b^{4}+5716824118452685579432a^{6}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(173659393928659459392a^{7}b^{4}+76408301725468014302a^{8}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1705097951760448960a^{9}b^{4}+382981184786432232a^{10}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(5748183402410176a^{11}b^{4}+739094390507564a^{12}b^{4}+6601942737600a^{13}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(510864616600a^{14}b^{4}+2038362560a^{15}b^{4}+95548245a^{16}b^{4})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-55034701912518351591456b^{5}+285611154005039511961584ab^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-31537703278468962890016a^{2}b^{5}+118731229184286059092336a^{3}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

Global Journal of Science Frontier Research Volume XI Issue VIII Version I November 2011

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$$+\frac{2097152(774244540786354732640a^{4}b^{5}+879860720353848290948\,8a^{5}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(176035164115167701344a^{6}b^{5}+189881872539940117680a^{7}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(34180434160788801 60a^{8}b^{5}+1440342352090916560a^{9}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(18912462302333600a^{10}b^{5}+4072058462779216a^{11}b^{5}+33224290546720a^{12}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4082173819920a^{13}b^{5}+15287719200a^{14}b^{5}+1121099408a^{15}b^{5})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(3069613506920738381037 6b^{6}-1771018749639069464051 2ab^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4957995983642819805781 6a^{2}b^{6}-2613497180326239520768a^{3}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(758168389436631526880 8a^{4}b^{6}+2042956225725583168 0a^{5}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(27836173850709335311 2a^{6}b^{6}+31973717172880271 36a^{7}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(3279322945283002904a^{8}b^{6}+343161974348793 60a^{9}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(13725332250654024a^{10}b^{6}+97498766124032a^{11}b^{6}+19915668515288a^{12}b^{6})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(68049950080a^{13}b^{6}+7898654920a^{14}b^{6}-2343992158584420586080b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(938719663373350241070 4ab^{7}-1847060337580314435904a^{2}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{2097152(3622196907545420899552a^{3}b^{7}-1038509014586316004 16a^{4}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(244302154198631848176a^{5}b^{7}+26575575468943987 2a^{6}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4641765626221435712a^{7}b^{7}+30170018493824352a^{8}b^{7}+2930355437006712 0a^{9}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(164092203484352a^{10}b^{7}+61905754398176a^{11}b^{7}+183248794144a^{12}b^{7})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(35240152720a^{13}b^{7}+6078300429274278648 02b^{8}-434768252883794087648ab^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(914874909079607142212a^{2}b^{8}-840328732982052508 48a^{3}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(127613060239609321806a^{4}b^{8}-20969694717364947 84a^{5}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(4127078539954327672a^{6}b^{8}+1603091087193024a^{7}b^{8}+40409776620754398a^{8}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1373259655310 40a^{9}b^{8}+125931280354308a^{10}b^{8}+291042202464a^{11}b^{8})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(103077446706a^{12}b^{8}-317566230339634305 12b^{9}+1091146309132723381 20ab^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-266024753489267046 56a^{2}b^{9}+385627700553496463 92a^{3}b^{9})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-2020184418709184a^{3}b^{12}+1832773289716460a^{4}b^{12}-49222930655808a^{5}b^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(36992002900216a^{6}b^{12}-194028134976a^{7}b^{12}+151584480450a^{8}b^{12})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

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$$+\frac{2097152(-333885390472608b^{13}+943016570640688ab^{13}-243072775316000a^{2}b^{13})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(253385470855664a^{3}b^{13}-13093578701280a^{4}b^{13}+9525291762448a^{5}b^{13})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-98672427616a^{6}b^{13}+63432274896a^{7}b^{13}+17769956078408b^{14})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-137148813564 16ab^{14}+19271530266616a^{2}b^{14}-1963099942400a^{3}b^{14})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1532005860600a^{4}b^{14}-29164264320a^{5}b^{14}+17620076360a^{6}b^{14})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-267913306080b^{15}+698946258192ab^{15}-156953917120a^{2}b^{15})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(145742923040a^{3}b^{15}-5095906400a^{4}b^{15}+3159461968a^{5}b^{15}+8671926933b^{16})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-5869933264ab^{16}+7503722174a^{2}b^{16}-509590640a^{3}b^{16}+350343565a^{4}b^{16})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(-742044424b^{17}+178275708ab^{17}-26978328a^{2}b^{17}+22481940a^{3}b^{17})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}+$$

$$+\frac{2097152(1360134b^{18}-648128ab^{18}+749398a^{2}b^{18}-4920b^{19}+10660ab^{19}+41b^{20})}{\left[\prod_{\Phi=1}^{21}\left\{a-b-(2\Phi-1)\right\}\right]\left[\prod_{\Psi=1}^{20}\left\{a-b+(2\Psi-1)\right\}\right]}\Bigg\}\Bigg]$$

III. Derivation of The Main Summation Formula

Applying parallel method discovered jointly by both the authors in [5 ; 6], we get the main result.

IV. Acknowledgement

One author [MPC] would like to thank to the Department of Science and Technology, Government of India, New Delhi, for financial assistance, and Centre for Mathematical Sciences for providing necessary facilities.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

Supporting Queries with Imprecise Constraints in Total Neutrosophic Databases

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Abstract - Neutrosophic relation database model has been developed for representing and manipulating three kinds of uncertain information in databases: fuzzy, incomplete and inconsistent. The neutrosophic set is a powerful general formal framework that has been recently proposed. However, the neutrosophic set needs to be specified from a technical point of view. In order to handle inconsistent situation, we propose the relation-theoretic operations on them. We define algebraic operators that are generalizations of the usual operators such as intersection, union, selection, and join on fuzzy relations. We present an SQL–like SELECT statement construct for posing queries to total neutrosophic databases. The syntax and semantics of SELECT statement is defined for making it an effective tool for querying.

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GJSFR-A Classification : FOR Code: 010206, 080604

SUPPORTING QUERIES WITH IMPRECISE CONSTRAINTS IN TOTAL NEUTROSOPHIC DATABASES

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Supporting Queries with Imprecise Constraints in Total Neutrosophic Databases

Meena Arora[α], Dr.U.S.Pandey[Ω]

Abstract - Neutrosophic relation database model has been developed for representing and manipulating three kinds of uncertain information in databases: fuzzy, incomplete and inconsistent. The neutrosophic set is a powerful general formal framework that has been recently proposed. However, the neutrosophic set needs to be specified from a technical point of view. In order to handle inconsistent situation, we propose the relation-theoretic operations on them. We define algebraic operators that are generalizations of the usual operators such as intersection, union, selection, and join on fuzzy relations. We present an SQL–like SELECT statement construct for posing queries to total neutrosophic databases. The syntax and semantics of SELECT statement is defined for making it an effective tool for querying.

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I. Introduction

Essentially all the information in the real world is imprecise, here imprecise means fuzzy, incomplete and even inconsistent. There are many theories existing to handle such imprecise information, such as fuzzy set theory, probability theory, probability theory, intuitionistic fuzzy set theory, vague theory, etc. These theories can only handle one aspect of imprecise problem but not the whole in one framework. For example, fuzzy set theory can only handle fuzzy, vague information not the incomplete and inconsistent information.

In this paper, we unify the above-mentioned theories under one framework. Under this framework, we can not only model and reason with fuzzy, incomplete information but also inconsistent information without danger of trivialization.

Relational data model, proposed by Ted Codd's pioneering paper [2] usually takes care of only well-defined and unambiguous data. However, imperfect information is ubiquitous, almost all the information that we have about the real world is not certain, complete and precise [10]. Imperfect information can be classified as: incompleteness, imprecision, uncertainty, inconsistency.

In order to represent and manipulate various forms of incomplete information in relational databases, several extensions of the classical relational model have been proposed [1, 3, 5, 8, 12, 13]. In some of these extensions, a variety of "null values" have been introduced to model unknown or not-applicable data values. Attempts have also been made to generalize operators of relational algebra to manipulate such extended data models [1, 3, 5, 6, 7].

Probability, possibility and Dempster-Shafer theory have been proposed to deal with uncertainty. Possibility theory [8] is built upon the idea of a fuzzy restriction. Wong [4] proposes a method that quantifies the uncertainty in a database using probabilities. Carvallo and Pittarelli [9] also use probability theory to model uncertainty in relational databases systems.

However, unlike incomplete, imprecise and uncertain information, inconsistent information has not enjoyed enough research attention. In fact, inconsistent information exists in a lot of applications.

For example, in data warehousing application, inconsistency will appear when trying to integrate the data from many different sources. Another *example* is that in the expert system, there exist facts which are inconsistent with each other.

We introduce neutrosophic relations and algebraic operators over neutrosophic relations that extend the standard operators such as selection, join, and union over vague relations. There are many potential applications of our new data model e.g. in Web mining, Bioinformatics, Decision Support System.

In this paper, we present an extension of the SQL SELECT statement for querying such databases. The syntax of this extended statement is similar to that of the ordinary SELECT statement; the semantics that we propose is quite different. With our new extended semantics, the statement becomes an effective tool for querying neutrosophic relational data model

The remainder of this paper is organized as follows. Section 2 presents a brief introduction of neutrosophy, neutrosophic sets. Section 3 gives a quick overview of total neutrosophic relations. Section 4 presents generalized algebra on neutropsophic relations with relational theoretic operators. Section 5 presents the syntax &new semantics of SQL-like SELECT statement for querying neutrosophic databases based on algebraic operators that are defined in section 4. Section 6 contains an example SELECT statement and a walk through the evaluation procedure for that query. Section 7 presents the area of application where this can be applied in real life. Finally, Section 8 concludes

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the paper with some mention of related and future work directions.

II. Neutrosophic Logic and Neutrosophic Sets

a) Neutrosophic logic

Neutrosophic logic was created by Florentin Smarandache (1995) [11] and is an extension/combination of the fuzzy logic, intuitionistic logic, paraconsistent logic, and the three-valued logics that use an indeterminate value.

Definition 1 Neutrosophic Logic : A logic in which each proposition is estimated to have the percentage of truth in a subset T, the percentage of indeterminacy in a subset I, and the percentage of falsity in a subset F, is called *Neutrosophic Logic*. T, I, F are standard or non-standard subsets of the nonstandard interval $]-0, 1+[$, where $n_{\inf} = \inf T + \inf I + \inf F \geq -0$, and $n_{\sup} = \sup T + \sup I + \sup F \leq 3+$.

Definition 2 (Neutrosophic Set): Let X be a space of points (objects), with a generic element in X denoted by x. A neutrosophic set A in X is characterized by a truth-membership function T_A, an indeterminacy-membership function I_A and a falsity-membership function F_A . $T_A(x), I_A(x)$ and $F_A(x)$ are real standard or non-standard subsets of$]-0, 1+[$. That is

$$T_A: X \rightarrow]^-0, 1^+[\quad (1)$$

$$I_A: X \rightarrow]^-0, 1^+[\quad (2)$$

$$F_A: X \rightarrow]^-0, 1^+[\quad (3)$$

There is no restriction on the sum of $T_A(x), I_A(x)$ and $F_A(x)$ so $-0 \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3+$.

b) Operations with sets

Let S_1 and S_2 be two (unidimensional) real standard or non-standard subsets, then one defines [11]

Addition of sets:

$S_1 + S_2 = \{x | x = s_1 + s_2$, where $s_1 \in S_1$ and $s_2 \in S_2\}$,

with inf $S_1 + S_2 = \inf S_1 + \inf S_2$, $\sup S_1 + S_2 = \sup S_1 + \sup S_2$;

Subtraction of sets:

$S_1 - S_2 = \{x | x = s_1 - s_2$, where $s_1 \in S_1$ and $s_2 \in S_2\}$.

For real positive subsets (most of the cases will fall in this range) one gets

$$\inf S_1 - S_2 = \inf S_1 - \sup S_2, \sup S_1 - S_2 = \sup S_1 - \inf S_2;$$

Multiplication of sets:

$S_1 . S_2 = \{x | x = s_1 . s_2$, where $s_1 \in S_1$ and $s_2 \in S_2\}$.

For real positive subsets (most of the cases will fall in this range) one gets

$$\inf S_1 . S_2 = \inf S_1 \inf S_2, \sup S_1 \cdot S_2 = \sup S_1 \cdot \sup S_2;$$

Division of a set by a number:

Let $k \in R^*$, then $S_1 \emptyset k = \{x | x = s_1 / k$, where $s_1 \in S_1\}$.

For all neutrosophic set operations: if, after calculations, one obtains numbers < 0 or > 1, one replaces them by $^-0$ or 1^+ respectively.

Definition 3. (Complement) : The complement of a neutrosophic set A is denoted by c(A) and is defined by

$$T_{c(A)}(x) = \{1^+\} - T_A(x), \quad (4)$$

$$I_{c(A)}I(x) = \{1^+\} - I_A(x), \quad (5)$$

$$F_{c(A)}(x) = \{1^+\} - F_A(x), \quad (6)$$

for all x in X.

Definition 4. (Union) : The union of two neutrosophic sets A and B is a neutrosophic set C, written as $C = A \cup B$, whose truth-membership, indeterminacy - membership and falsity-membership functions are related to those of A and B by

$$T_C(x) = T_A(x) + T_B(x) - T_A(x) \times T_B(x), \quad (7)$$

$$I_C(x) = I_A(x) + I_B(x) - I_A(x) \times I_B(x), \quad (8)$$

$$F_C(x) = F_A(x) + F_B(x) - F_A(x) \times F_B(x), \quad (9)$$

for all x in X.

Definition 5. (Intersection) : The intersection of two neutrosophic sets A and B is a neutrosophic set C, written as $C = A \cap B$, whose truth-membership, indeterminacy-membership and falsity-membership functions are related to those of A and B by

$$T_C(x) = T_A(x) \times T_B(x), \quad (10)$$

$$I_C(x) = I_A(x) \times I_B(x), \quad (11)$$

$$F_C(x) = F_A(x) \times F_B(x), \quad (12)$$

for all x in X.

III. Total Neutrosophic Relations

In this section, we introduce neutrosophic relations. A tuple in a neutrosophic relation is assigned a measure

$$\langle \alpha, \beta \rangle, 0 \leq \alpha, \beta \leq 1.$$

Definition 6 Belief factor : The interpretation of this measure is that we believe with confidence α that the tuple is in the relation.

In a neutrosophic relation $R, R(t)^+$ is the belief factor assigned to t by R.

Definition 7. Doubt factor : The interpretation of this measure is that we doubt with confidence β that the tuple is in the relation.

Global Journal of Science Frontier Research Volume XI Issue VIII Version I November 2011

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In a neutrosophic relation $R, R(t)^{-}$ is the doubt factor assigned to t by R.

The belief and doubt confidence factors for a tuple need not add to exactly 1. This allows for incompleteness and inconsistency to be represented. If the belief and doubt factors add up to less than 1, we have incomplete information regarding the tuple's status in the relation and if the belief and doubt factors add up to more than 1, we have inconsistent information regarding the tuple's status in the relation.

In contrast to fuzzy relations where the grade of membership of a tuple is fixed, neutrosophic relations bound the grade of membership of a tuple to a subinterval [α , $1-\beta$] for the case $\alpha + \beta \leq 1$.

We now formalize the notion of a neutrosophic relation. Let a relation scheme (or just scheme) Σ be a finite set of attribute names, where for any attribute name $A \in \Sigma$, dom(A) is a non-empty set of distinct values for A. A tuple on Σ is any total map $t: \Sigma \rightarrow \cup_{A \in \Sigma}$ dom (A), such that $t(A) \in$ dom(A), for each $A \in \Sigma$. Let

$\tau(\Sigma)$ denotes the set of all tuples on any schemeΣ.

(Σ) be the set of all total neutrosophic relations on Σ .

$R(t)^{+}$is the belief factor,

$R(t)^{-}$ is the doubt factor ,

$C(\Sigma)$ be the set of all consistent neutrosophic relations on.

$\mathcal{V}(\Sigma)$be the set of all neutrosophic relations onΣ.

Definition 8 : A neutrosophic relation R on scheme Σ is any subset of $\tau(\Sigma) \times [0,1] \times [0,1]$.

For any $\in \tau(\Sigma)$, we shall denote an element of R as $\langle t, R(t)^{+}, R(t)^{-} \rangle$ where $R(t)^{+}$ is the belief factor assigned to t by R and $R(t)^{-}$ is the doubt factor assigned to t by R. Let $\mathcal{V}(\Sigma)$ be the set of all neutrosophic relations on Σ.

Definition 9 : A neutrosophic relation R on scheme Σ is consistent if $R(t)^{+} + R(t)^{-} \leq 1$, for all $t \in \tau(\Sigma)$.

Let $C(\Sigma)$be the set of all consistent neutrosophic relations on ΣR is said to be complete if $R(t)^{+} + R(t)^{-} \geq 1$, for all $t \in \tau(\Sigma)$. If R is both consistent and complete, i.e.$R(t)^{+} + R(t)^{-} = 1$, for all t $\in \tau(\Sigma)$,then it is a **total neutrosophic relation**,and let $(T\Sigma)$ be the set of all total neutrosophic relations onΣ.

For any t $\in \tau$ (Σ), we shall denote an element of R as <t, $R(t)^{+}$, $R(t)^{-}$ >,where $R(t)^{+}$ is the belief factor assigned to t by R and $R(t)^{-}$ is the doubt factor assigned to t by R. Note that since contradictory beliefs are possible, so $R(t)^{+}$ + $R(t)^{-}$ could be greater than 1. Furthermore, $R(t)^{+}$ + $R(t)^{-}$ could be less than 1, giving rise to incompleteness.

As an *example*, suppose in the e-shopping environment, there are two items $Item_1$ and $Item_2$, which are evaluated by customers for some categories of quality - Capability, Trustworthiness and Price. Let the evaluation results are captured by the following total neutrosophic relation EVAL_RESULT on scheme {Item_Name, Quality_Category} as shown in Table 1:

Table 1: Eval_Result

Item_Name	Quality_Category	Evaluation
$Item_1$	Capability	(0.9,0.2)
$Item_1$	Trustworthiness	(1.0,0.0)
$Item_1$	Price	(0.1,0.8)
$Item_2$	Capability	(1.0,1.0)
$Item_2$	Price	(0.8,0.3)

The above relation contains the information that the confidence of $Item_1$ was evaluated "good" for category Capability is 0.9 and the doubt is 0.2. The confidence of $Item_1$ was evaluated "good" for category Trustworthiness is 1.0 and the doubt is 0.0. The confidence of $Item_1$ was evaluated "poor" for category Price is 0.8 and the doubt is 0.1. Also, the confidence of $Item_2$was evaluated "good" for category Capability is 1.0 and the doubt is 1.0 (similarly, the confidence of $Item_2$ was evaluated "poor" for category Capability is 1.0 and the doubt is 1.0). The confidence of $Item_2$ was evaluated "good" for category Price is 0.8 and the doubt is 0.3. Note that the evaluation results of $Item_2$ for category Trustworthiness is unknown. The above information contains results of fuzziness, incompleteness and inconsistency. Such information may be due to various reasons, such as evaluation not conducted, or evaluation results not yet available, the evaluation is not reliable, and different evaluation results for the same category producing different results, etc.

IV. Algebra on Total Neutrosophic Relations

In this section, we briefly introduce relational theoretic operators (natural join, projection, product, selection) for the semantics of SELECT statement in queries used in Neutrosopic Search. These generalized operators maintain the belief system intuition behind neutrosophic relations.

a) Relation-Theoretic operators

We now define some generalized relation-theoretic algebraic operators (like join, product, selection, projection) on total neutrosophic relations to complete the semantics of SELECT statement. To reflect such generalizations a subscript 't' is placed aside on an ordinary relation operator to obtain corresponding total neutrosophic relational operator.

Definition 10 : Let R and S be neutrosophic relations on schemeΣ. Then,

The union operator can be obtained as follows: Given a tuple t, since we believed that it is present in the relation R with confidence $R(t)^{+}$ and that it is present in the relation S with confidence $S(t)^{+}$, we can now

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believe that the tuple t is present in the "either-R-or- S" relation with confidence which is equal to the larger of $R(t)^+$ and $S(t)^+$. Using the same logic, we can now believe in the absence of the tuple t from the "either-R-or-S" relation with confidence which is equal to the smaller (because t must be absent from both R and S for it to be absent from the union) of $R(t)^-$ and $S(t)^-$.

$(R \cup^t S)(t) = \langle\ max\ \{ R\ (t)^+ , S(t)^+ \}, min\ \{ R\ (t)^- , S(t)^- \} \rangle$, for any $t \in \tau(\Sigma)$;

Definition 11 : Let R and S be neutrosophic relations on schemes Σ and Δ , respectively. Then, the **natural join** (further for short called join) of R and S, denoted $R \bowtie^t S$, is a total neutrosophic relation on scheme $\Sigma \cup \Delta$, given by

$$(R \bowtie^t S)(t) = \langle \min \{ R(\pi_\Sigma(t))^+ , S(\pi_\Delta(t))^+ \},\ \max \{ R(\pi_\Sigma(t))^- , S(\pi_\Delta(t))^- \} \rangle,$$

Where π is the usual projection of a tuple.

Similar to the intersection operator, the minimum of the belief factors and the maximum of the doubt factors are used in the definition of the join operation.

We now define the projection operator on total Neutrosophic relation.

Definition 12 : Let R be a neutrosophic relation on scheme Σ and $\Delta \subseteq \Sigma$ Then, the **projection** of R onto Δ, denoted by π^t_Δ(R), is a total neutrosophic relation on scheme Δ, given by

$$(\pi^t_\Delta (R))(t) = \langle \max \{ R(u)^+ \mid u \in t^\Sigma \}, \min \{ R(u)^- \mid u \in t^\Sigma \} \rangle$$

The belief factor of a tuple in the projection is the maximum of the belief factors of all of the tuple's extensions onto the scheme of the input neutrosophic relation. Moreover, the doubt factor of a tuple in the projection is the minimum of the doubt factors of all of the tuple's extensions on to the scheme of the input neutrosophic relation.

Definition 13 : For any total Neutrosophic relation R and S, $R \times^t S = \mathcal{t}(R) \bowtie^t \mathcal{t}(S)$.

The **product** of total Neutrosophic relation R and S is essentially a join after renaming their attributes to make their schemes disjoint. Let $\mathcal{t}$(R) be the total Neutrosophic relation in totality with the same tuples in R, but with attribute names of the form "R.A" for each attribute name A of R.

We will now define the **selection operator** on total neutrosophic relations.

Definition 14 : Let R be a total neutrosophic relation on scheme Σ, and C be a condition on tuples of Σ denoted $\langle t_c(t), f_C(t)\rangle$.Then, the selection of R by C, denoted by σ^t_C(R) is a total neutrosophic relation on scheme Σ, given by

$$(\sigma^t_C(R))(t) = \langle \min R(t)^+ , t_c(t), \max R(t)^- , f_C(t) \rangle.$$

In the generalized SELECT statement, we let the condition occurring in the where clause be infinite valued. The infinite values, except $\langle 1,0\rangle$ or $\langle 0,1\rangle$, arise essentially due to any nested subqueries.For any arithmetic expressions E_1 and E_2, comparisons such as $E_1 \le E_2$ are simply 2-valued conditions ($\langle 1,0\rangle$ or $\langle 0,1\rangle$) . Let ξ be a subquery of the form (select …… from ……. where …….) occurring in the where clause of a SELECT statement. And let R be the neutrosophic relation on scheme Σ that the subquery ξ evaluates to. Then, conditions involving the subquery ξ evaluate as follows.

1. The condition exists ξ evaluates to $\langle\alpha, \beta\rangle$
   $\alpha = \max \{a\}$, $a = R(t)^+$, for all $t \in \tau(\Sigma)$,
   $\beta = \min \{b\}$, $b = R(t)^-$, if $R(t)^+ + R(t)^- \le 1$, $b = 1 - R(t)^+$, if $R(t)^+ + R(t)^- > 1$, for all $t \in \tau(\Sigma)$.
2. For any tuple $t \in \tau(\Sigma)$, the condition
   T in ξ
   Evaluates to Φ_R (t).
3. If Σ contains exactly one attribute, then for any (scalar value) $t \in \tau(\Sigma)$, the condition
   t > any ξ
   evaluates to $\langle\alpha, \beta\rangle$,

$\alpha = \max \{a\}$, $a = R(k)^+$, if $t > k$, for some $k \in R$, ($\beta = \min \{b\}$, $b = R(k)^-$, if $R(k)^+ + R(k)^- \le 1$,
$B = 1 - R(k)^+$, if $R (k)^+ + R (k)^- > 1$) , if t >k, for some $k \in R$;

$\alpha = 0$, $\beta = 1$, otherwise

Note that conditions involving such operators never evaluate to the value α, β such that

$$\alpha + \beta > 1.$$

We complete our semantics for conditions by defining the **not**, **and** and **or** operators on them. Let C and D be any conditions, and value of C = $<t_c, f_c>$ and value of D = $<t_d, f_d>$.Then, the value of the condition not C is given by

not C = $<f_c, t_c>$

while the value of the condition C and D is given by

C and D = $<\min \{ t_c, t_d \}, \max\{ f_c, f_d \}>$

and that of the condition C or D is given by

C or D = $<\max \{ t_c, t_d\}, \min\{f_c, f_d\}>$.

The duality of *and* and *or* is evident from their formulas. The following algebraic laws exhibited by the above operators:

1. Double Complementation Law: not (not C) = C
2. Identity and Idempotence Laws:
   C and <1, 0 > = C and C = C
   C or <0, 1> = C or C = C
3. Commutativity Laws:
   C and D = D and C
   C or D = D or C
4. Associativity Laws:
   C and (D and E) = (C and D) and E
   C or (D or E) = (C or D) or E
5. Distributivity Laws:
   C and (D or E) = (C and D) or (C and E)

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C or (D and E) = (C or D) and (C or E)

6. De Morgan Laws:

   not (C and D) = (not C) or (not D)

   not (C or D) = (not C) and (not D)

V. Syntax and Semantics of SELECT Queries For Total Neutrosophic Relations

The most popular construct for information retrieval from most commercial systems is the SQL's SELECT statement. While the statement has many options and extensions to its basic form, here we just present generalization for total neutrosophic relations. The basic form of the statement contains three clauses select, from and where, and has the following format:

Select $A_1, A_2, \ldots A_m$ From $R_1, R_2, \ldots, R_n$ where C

Where

1. $A_1, A_2, \ldots\ldots\ldots A_m$ is a list of attribute names whose values are to be retrieved by the query,
2. $R_1, R_2, \ldots\ldots\ldots, R_n$ is a list of relation names required to process the query, and
3. C is a boolean expression that identifies the tuples to be retrieved by the query.

Without loss of generality, we assume that each attribute name occurs in exactly one relation, because if some attribute A_i occurs in more than one relation, we require, instead of simply the attribute A_i, a pair of the form $R_j .A_i$ qualifying that attribute. The result of the SELECT statement is a relation with attributes $A_1, A_2, \ldots\ldots\ldots A_m$ chosen from the attributes of $R_1 \times R_2 \times \ldots\ldots\ldots \times R_n$ for tuples that satisfy the Boolean condition C, i.e.

$$\pi_{A1,A2,\ldots\ldots\ldots Am}(\sigma_C(R_1 \times R_2 \times \ldots\ldots\ldots \times R_n))$$

where $\pi, \sigma, \times$ and _ are the projection, selection and product operations, respectively, on ordinary relations. We retain the above syntax in the generalized SELECT statement for the total neutrosophic relations. However, the relation names $R_1, R_2, \ldots\ldots\ldots, R_n$ now represent some neutrosophic relations and C is some infinite-valued condition. The result of the generalized SELECT statement is then the value of the algebraic expression:

$$\pi^t_{A1,A2,\ldots\ldots\ldots Am}(\sigma^t_C(R_1 \times^t R_2 \times^t \ldots\ldots\ldots \times^t R_n))$$

Where π^t, σ^t, $\times^t$ are, respectively, the projection, selection and product operations on total neutrosophic relations. Furthermore , the result of the generalized SELECT statement is also a total neutrosophic relation.

VI. A Walk Through of The Evaluation For an Example

Let us now consider a **query**:

What items showed contradictory evaluation of some category of quality in the total neutrosophic relation EVAL as shown in TABLE 2. on scheme {ITEM_Name, Quality_Category} of the item-quality .

Table 2 : Eval_Result

Item_Name	Quality_Category	Evaluation
$Item_1$	Capability	(0.9,0.2)
$Item_1$	Trustworthiness	(1.0,0.0)
$Item_1$	Price	(0.1,0.8)
$Item_2$	Capability	(1.0,1.0)
$Item_2$	Price	(0.8,0.3)

Solution :

A SELECT statement for this query is:

Select Item_Name from EVAL_RESULT where not ((Item_name, Quality_Category) in EVAL_RESULT).

One possible evaluation method for the above query in ordinary 2-valued SQL is to produce the Item attribute of those rows of EVAL_RESULT that satisfy the where condition. Since the where condition in the above case is exactly that row not be in EVAL_RESULT, in 2-valued logic the above query will produce an empty answer.

The stepwise output is shown below :

In neutrosophic logic, however, the where condition needs to be evaluated, to one of infinite possible values, for every possible row with attributes Σ = (Item_name, Quality_Category). The result is then combined with EVAL_RESULT according to the semantics of σ^t, on which π^t is performed to produce the resulting total neutrosophic relation. Therefore, for each of the 6 rows in $\tau(\Sigma)$, we first evaluate the where condition C is as shown in Table 3:

Table 3 : Relation Schema With Condition

(Item_Name, Quality _Category)	C= not (((Item_Name, Quality_Category) in EVAI_RESULT)
($Item_1$, Capability)	⟨0.2, 0.9⟩
(tem_1, Trustworthiness)	⟨0.0,1.0⟩
($Item_1$, Price)	⟨0.8,0.1⟩
($Item_2$, Capability)	⟨1.0,1.0⟩
($Item_2$ Trustworthiness)	⟨0.0,0.0⟩
($Item_2$ Price)	⟨0.3,0.8⟩

Now, σ^t_C(EVAL) according to the definition of σ^t evaluates to the total neutrosophic relation is as shown in Table 4.

σ^t_C(EVAL)

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Table 4 : Relation Schema With Select Clause

Item_Name	Quality_Category	Evaluation
$Item_1$	Capability	(0.2,0.9)
$Item_1$	Trustworthiness	(0.0,1.0)
$Item_1$	Price	(0.1,0.8)
$Item_2$	Capability	(1.0,1.0)
$Item_2$	Price	(0.3,0.8)

Finally, π^t of the above is the total neutrosophic relation as shown in Table 5.:

$$\pi_I^t(\sigma_C^t(\text{EVAL}))$$

Table 5 : Relation Schema With Project Clause

ITEM_Name	Evaluation
$Item_1$	(0.1,0.8)
$Item_2$	(1.0,0.0)

which is the result of the SELECT statement.

Explanation :

The result states that $Item_1$ showed contradictory evaluation result for some category with confidence is 0.1 and doubt is 0.8, so it is safe to conclude that $Item_1$ did not show contradictory evaluation result, but $Item_2$ showed contradictory evaluation result for some category with confidence 1.0 and doubt is 0.0, the explanation is that $Item_2$ did show contradictory result for some category and did not show contradictory for other category at the same times.

VII. Application

Web services are playing an important role in e-business application integration and other application fields such as bioinformatics. So it is crucial for the success of both service providers as well as service consumers to provide and invoke the high quality of service (QoS) Web services. Since different application domains have different requirements for QoS it is impractical to use classical mathematical modeling methods to evaluate the QoS of semantic Web services. Our model is scalable to handle fuzzy, uncertain and inconsistent QoS metrics effectively. For example, capability of a Web service is fuzzy. It is unreasonable to use crisp values to describe it. So we can use several linguistic variables such as a "little bit low" and "a little bit high" to express the capability of services.

VIII. Conclusions

How to model and reason with fuzzy, incomplete and even inconsistent information is an important research topic. In this paper we have presented syntax & semantics for the SQL SELECT statement for querying neutrosophic databases. We have presented a generalization of fuzzy relations, intuitionistic fuzzy relations (interval valued fuzzy relations) and vague relations, called total neutrosophic relations, in which we allow the representation of confidence (belief and doubt) factors with each tuple.

We introduced generalized operators on total neutrosophic relations. These generalized operators maintain the belief system intuition behind neutrosophic relations. We have given the syntax & extended semantics for the SELECT statement based on the extended algebraic operators (projection, selection and product) on neutrosophic relations.

As the future work, we plan to extend this work to develop tuple-relational and domain-relational calculus for the total neutrosophic relations.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

Construction of A Summation Formula Allied with Hyper - geometric Function and Involving Recurrence Relation

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GJSFR-A Classification : *FOR Code: 010206, 080604*

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Construction of A Summation Formula Allied with Hypergeometric Function and Involving Recurrence Relation

Salahuddin

Abstract - The main aim of this paper is to create a summation formula associated to recurrence relation and Hypergeometric function.

Keywords : *Contiguous relation,Recurrence relation, Gauss second summation theorem .*

I. Introduction

Generalized Gaussian Hypergeometric function of one variable :

$$ {}_AF_B\left[\begin{matrix} a_1, a_2, \cdots, a_A & ; \\ & & z \\ b_1, b_2, \cdots, b_B & ; \end{matrix}\right] = \sum_{k=0}^{\infty} \frac{(a_1)_k (a_2)_k \cdots (a_A)_k z^k}{(b_1)_k (b_2)_k \cdots (b_B)_k k!} \tag{1} $$

or

$$ {}_AF_B\left[\begin{matrix} (a_A) & ; \\ & & z \\ (b_B) & ; \end{matrix}\right] \equiv {}_AF_B\left[\begin{matrix} (a_j)_{j=1}^A & ; \\ & & z \\ (b_j)_{j=1}^B & ; \end{matrix}\right] = \sum_{k=0}^{\infty} \frac{((a_A))_k z^k}{((b_B))_k k!} \tag{2} $$

where the parameters b1, b2, $\cdots$, b_B are neither zero nor negative integers and A, B are non-negative integers.

Contiguous Relation :

[Abramowitz p.558(15.2.19)]

$$ (a-b)\,(1-z)\,{}_2F_1\left[\begin{matrix} a, & b\ ; \\ c & ; \end{matrix}\ z\right] = (c-b)\,{}_2F_1\left[\begin{matrix} a, & b-1 & ; \\ & c & ; \end{matrix}\ z\right] + (a-c)\,{}_2F_1\left[\begin{matrix} a-1, & b & ; \\ c\ ; & & \end{matrix}\ z\right] \tag{3} $$

Recurrence relation :

$$ \Gamma(z+1) = z\ \Gamma(z) \tag{4} $$

Legendre's duplication formula :

$$ \sqrt{\pi}\ \Gamma(2z) = 2^{(2z-1)}\ \Gamma(z)\ \Gamma\left(z+\frac{1}{2}\right) \tag{5} $$

$$ \Gamma\left(\frac{1}{2}\right) = \sqrt{\pi} = \frac{2^{(b-1)}\ \Gamma(\frac{b}{2})\ \Gamma(\frac{b+1}{2})}{\Gamma(b)} \tag{6} $$

$$ = \frac{2^{(a-1)}\ \Gamma(\frac{a}{2})\ \Gamma(\frac{a+1}{2})}{\Gamma(a)} \tag{7} $$

In the monograph of Prudnikov et al., a summation formula is given in the form [Prudnikov, 491, equation(7.3.7.3)]

$$ {}_2F_1\left[\begin{matrix} a, & b & ; \\ \frac{a+b-1}{2} & & ; \end{matrix}\ \frac{1}{2}\right] = \sqrt{\pi}\left[\frac{\Gamma(\frac{a+b+1}{2})}{\Gamma(\frac{a+1}{2})\Gamma(\frac{b+1}{2})} + \frac{2\ \Gamma(\frac{a+b-1}{2})}{\Gamma(a)\Gamma(b)}\right] \tag{8} $$

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Now using Legendre's duplication formula and Recurrence relation for Gamma function, the above formula can be written in the form

$$ {}_2F_1\left[\begin{matrix} a, & b & ; & \frac{1}{2} \\ \frac{a+b-1}{2} & & ; & \end{matrix}\right] = \frac{2^{(b-1)}\ \Gamma(\frac{a+b-1}{2})}{\Gamma(b)}\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a-1}{2})} + \frac{2^{(a-b+1)}\ \Gamma(\frac{a}{2})\ \Gamma(\frac{a+1}{2})}{\{\Gamma(a)\}^2} + \frac{\Gamma(\frac{b+2}{2})}{\Gamma(\frac{a+1}{2})}\right] \quad (9) $$

It is noted that the above formula [Prudnikov, 491, equation (7.3.7.3)], i.e.equation(8) or (9) is not correct.The correct form of equation(8) or (9) is obtained by [Asish et. al(2008), p.337(10)]

$$ {}_2F_1\left[\begin{matrix} a, & b & ; & \frac{1}{2} \\ \frac{a+b-1}{2} & & ; & \end{matrix}\right] = \frac{2^{(b-1)}\ \Gamma(\frac{a+b-1}{2})}{\Gamma(b)}\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a-1}{2})}\left\{\frac{(b+a-1)}{(a-1)}\right\} + \frac{2\ \Gamma(\frac{b+1}{2})}{\Gamma(\frac{a}{2})}\right] \quad (10) $$

Involving the formula obtained by [Asish et. al (2008), p.337 (10)], we establish the main formula.

II. Main Summation Formula

For the main formula $a \neq b$

$$ {}_2F_1\left[\begin{matrix} a, & b & ; & \frac{1}{2} \\ \frac{a+b-33}{2} & & ; & \end{matrix}\right] = \frac{2^{(b-1)}\ \Gamma(\frac{a+b-33}{2})}{(a-b)\Gamma(b)}\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a-33}{2})}\left\{\frac{(-6332659870762850625a)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + \right.\right. $$

$$ + \frac{(1518846502911432502 5a^2 - 14354510691610713240a^3 + 7524314127912551832a^4)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(-2523698606200763196a^5 + 585146416702456764a^6 - 98283050207112680a^7)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(12319487399406824a^8 - 1174199725349222a^9 + 86014818744998a^{10} - 4862169489320a^{11})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(211577650856a^{12} - 7020044668a^{13} + 174281212a^{14} - 3132760a^{15} + 38488a^{16} - 289a^{17})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(a^{18} + 6332659870762850625b - 21685865075950122360a^2b + 27174273987848799888a^3b)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(-14941382816881136916a^4b + 5514641320597784784a^5b - 1223922579902059240a^6b)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(223951372274069328a^7b - 25702619937058218a^8b + 2705684289022352a^9b)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}} + $$

$$ + \frac{(-173934158896520a^{10}b + 11136166030000a^{11}b - 402445286516a^{12}b + 15725518704a^{13}b)}{\prod_{\clubsuit=1}^{17} a-\{(2\clubsuit-1)\ \ \}} + $$

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$$+\frac{(-296201880a^{14}b+6703984a^{15}b-50575a^{16}b+560a^{17}b-151884650291143250 25b^{2})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(21685865075950122360ab^{2}-13682691432034310808a^{3}b^{2}+11066683826498381100a^{4}b^{2})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-3872556582071104200a^{5}b^{2}+1077310489531409840a^{6}b^{2}-161824805437466776a^{7}b^{2})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(24012617457411330a^{8}b^{2}-1869004163521880a^{9}b^{2}+166427533185760a^{10}b^{2})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-6955392355464a^{11}b^{2}+386494342780a^{12}b^{2}-8156169560a^{13}b^{2}+280185840a^{14}b^{2})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-2314312a^{15}b^{2}+45815a^{16}b^{2}+14354510691610713240b^{3}-27174273987848799888ab^{3})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(13682691432034310808a^{2}b^{3}-2823412677568587720a^{4}b^{3}+1630202936508633872a^{5}b^{3})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-374886600752864200a^{6}b^{3}+82069972989712224a^{7}b^{3}-8266545280520120a^{8}b^{3})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(1016286884813200a^{9}b^{3}-51348408517560a^{10}b^{3}+3905028076096a^{11}b^{3}-95843023640a^{12}b^{3})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(4626006000a^{13}b^{3}-43361560a^{14}b^{3}+1298528a^{15}b^{3}-7524314127912551832b^{4})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(14941382816881136916ab^{4}-11066683826498381100a^{2}b^{4}+2823412677568587720a^{3}b^{4})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-2397013532604327 56a^{5}b^{4}+105012931049313980a^{6}b^{4}-15843532755817360a^{7}b^{4})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(2814256196843080a^{8}b^{4}-182217872348820a^{9}b^{4}+18878387187660a^{10}b^{4})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

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$$+\frac{(-558624827320a^{11}b^4+36604618960a^{12}b^4-400108940a^{13}b^4+16811300a^{14}b^4)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(2523698606200763196b^5-5514641320597784784ab^5+3872556582071104200a^2b^5)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-1630202936508633872a^3b^5+239701353260432756a^4b^5-9306573013861200a^6b^5)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(3224351601798624a^7b^5-307619347906332a^8b^5+45369021123888a^9b^5)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-1706864738040a^{10}b^5+151079424048a^{11}b^5-1985995284a^{12}b^5+112971936a^{13}b^5)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-585146416702456764b^6+1223922579902059240ab^6-1077310489531409840a^2b^6)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(374886600752864200a^3b^6-105012931049313980a^4b^6+9306573013861200a^5b^6)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-170407715551920a^7b^6+48117783663180a^8b^6-2634364332600a^9b^6+328465903920a^{10}b^6)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-5456031000a^{11}b^6+417225900a^{12}b^6+98283050207112680b^7-223951372274069328ab^7)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(161824805437466776a^2b^7-82069972989712224a^3b^7+15843532755817360a^4b^7)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-3224351601798624a^5b^7+170407715551920a^6b^7-1398935518200a^8b^7+329434234800a^9b^7)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-7887861960a^{10}b^7+843621600a^{11}b^7-12319487399406824b^8+25702619937058218ab^8)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-24012617457411330a^2b^8+8266545280520120a^3b^8-2814256196843080a^4b^8)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

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$$+\frac{(307619347906332a^5b^8-48117783663180a^6b^8+1398935518200a^7b^8-4059928950a^9b^8)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(811985790a^{10}b^8+117419972534922 2b^9-2705684289022352ab^9+1869004163521880a^2b^9)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-1016286884813200a^3b^9+182217872348820a^4b^9-45369021123888a^5b^9)}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(2634364332600a^6b^9-329434234800a^7b^9+4059928950a^8b^9-86014818744998b^{10})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(173934158896520ab^{10}-166427533185760a^2b^{10}+51348408517560a^3b^{10})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-18878387187660a^4b^{10}+1706864738040a^5b^{10}-328465903920a^6b^{10}+7887861960a^7b^{10})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-811985790a^8b^{10}+4862169489320b^{11}-11136166030000ab^{11}+6955392355464a^2b^{11})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-3905028076096a^3b^{11}+558624827320a^4b^{11}-151079424048a^5b^{11}+5456031000a^6b^{11})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-843621600a^7b^{11}-211577650856b^{12}+402445286516ab^{12}-386494342780a^2b^{12})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(95843023640a^3b^{12}-36604618960a^4b^{12}+1985995284a^5b^{12}-417225900a^6b^{12})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(7020044668b^{13}-15725518704ab^{13}+8156169560a^2b^{13}-4626006000a^3b^{13}+400108940a^4b^{13})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-112971936a^5b^{13}-174281212b^{14}+296201880ab^{14}-280185840a^2b^{14}+43361560a^3b^{14})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

$$+\frac{(-16811300a^4b^{14}+3132760b^{15}-6703984ab^{15}+2314312a^2b^{15}-1298528a^3b^{15}-38488b^{16})}{\prod_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}+$$

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$$+\frac{(50575ab^{16}-45815a^2b^{16}+289b^{17}-560ab^{17}-b^{18})}{\prod\limits_{\clubsuit=1}^{17}\{a-(2\clubsuit-1)\}}\Bigg\}+\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a-32}{2})}\Bigg\{\frac{(1013341313560365405 0a)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-16516534255341284160a^2+12913410201153578352a^3-5134255758481893696a^4)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(1587404582027587896a^5-283859488061889600a^6+46858165261036304a^7)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-4462194675588672a^8+439713443065292a^9-23589705501120a^{10}+1446665758736a^{11})}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-43308178368a^{12}+1644188728a^{13}-25149120a^{14}+554608a^{15}-3264a^{16}+34a^{17})}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-10133413135603654050b+16931174426365770288a^2b-14906340904637522304a^3b)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(7884962414212007016a^4b-2042954269149525760a^5b+485108793688889104a^6b)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-59536895575144064a^7b+8016646272897108a^8b-523874269585920a^9b)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(43542297741008a^{10}b-1537398584960a^{11}b+80953284776a^{12}b-1435006720a^{13}b)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(46940400a^{14}b-319872a^{15}b+5950a^{16}b+16516534255341284160b^2)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-16931174426365770288ab^2+67250339319166445 28a^3b^2-3600430749436861760a^4b^2)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(1397408542187076048a^5b^2-241437978982668160a^6b^2+4569303994359121 6a^7b^2)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-3794731512686400a^8b^2+425328212299760a^9b^2-18176612312320a^{10}b^2)}{\prod\limits_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

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$$+\frac{(1288646146704a^{11}b^2-26912849600a^{12}b^2+1222187120a^{13}b^2-9694080a^{14}b^2+272272a^{15}b^2)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-1291341020115357835 2b^3+149063409046375223 04ab^3-672503393191664452 8a^2b^3)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(978138257795363280a^4b^3-334206391921947776a^5b^3+100224687519122320a^6b^3)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-11475840301911040a^7b^3+1778313651358640a^8b^3-95547195004800a^9b^3)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(9056404988400a^{10}b^3-227804308480a^{11}b^3+13899856880a^{12}b^3-129852800a^{13}b^3)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(5101360a^{14}b^3+5134255758481893696b^4-7884962414212007016ab^4)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(3600430749436861760a^2b^4-978138257795363280a^3b^4+62527488580332776a^5b^4)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-13739063876827520a^6b^4+3300339203735200a^7b^4-240722395488960a^8b^4)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(31178568063720a^9b^4-977960392640a^{10}b^4+79379902000a^{11}b^4-890081920a^{12}b^4)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(47071640a^{13}b^4-1587404582027587896b^5+2042954269149525760ab^5)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-1397408542187076048a^2b^5+334206391921947776a^3b^5-62527488580332776a^4b^5)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(1910209218847776a^6b^5-261663896938752a^7b^5+51709067642232a^8b^5-2176238211840a^9b^5)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(239444018352a^{10}b^5-3327537024a^{11}b^5+233646504a^{12}b^5+2838594880618896 00b^6)}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

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$$+\frac{(-485108793688889104ab^6+241437978982668160a^2b^6-100224687519122320a^3b^6)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(13739063876827520a^4b^6-1910209218847776a^5b^6+28409218881120a^7b^6)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(-2209930430400a^8b^6+366743454000a^9b^6-6778316160a^{10}b^6+641886000a^{11}b^6)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(-468581652610363304b^7+595368955751440 64ab^7-456930399435912 16a^2b^7)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(114758403019110 40a^3b^7-3300339203735200a^4b^7+261663896938752a^5b^7)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(-28409218881120a^6b^7+194057780400a^8b^7-6550473600a^9b^7+927983760a^{10}b^7)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(44621946755886672b^8-80166462728971 08ab^8+3794731512686400a^2b^8)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(-1778313651358640a^3b^8+240722395488960a^4b^8-51709067642232a^5b^8)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(2209930430400a^6b^8-194057780400a^7b^8+477638700a^9b^8-4397134430652 92b^9)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(523874269585920ab^9-425328212299760a^2b^9+95547195004800a^3b^9-31178568063720a^4b^9)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(2176238211840a^5b^9-366743454000a^6b^9+6550473600a^7b^9-477638700a^8b^9)}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(235897055011 20b^{10}-43542297741008ab^{10}+18176612312320a^2b^{10}-9056404988400a^3b^{10})}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

$$+\frac{(977960392640a^4b^{10}-239444018352a^5b^{10}+6778316160a^6b^{10}-927983760a^7b^{10})}{\prod_{♠=1}^{16}\{a-2♠\}}+$$

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$$+\frac{(-1446665758736b^{11}+1537398584960ab^{11}-1288646146704a^2b^{11}+227804308480a^3b^{11})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-79379902000a^4b^{11}+3327537024a^5b^{11}-641886000a^6b^{11}+433081783680b^{12})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-80953284776ab^{12}+26912849600a^2b^{12}-13899856880a^3b^{12}+890081920a^4b^{12})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-233646504a^5b^{12}-1644188728b^{13}+1435006720ab^{13}-1222187120a^2b^{13}+129852800a^3b^{13})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(-47071640a^4b^{13}+251491120b^{14}-46940400ab^{14}+9694080a^2b^{14}-5101360a^3b^{14}-554608b^{15})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}+$$

$$+\frac{(319872ab^{15}-272272a^2b^{15}+3264b^{16}-5950ab^{16}-34b^{17})}{\prod_{\spadesuit=1}^{16}\{a-2\spadesuit\}}\Bigg\}\Bigg] \quad (11)$$

III. Derivation of Main Summation Formula :

Substituting $c=\frac{a+b-33}{2}$ and $z=\frac{1}{2}$ in equation (3), we get

$$(a-b)\,{}_2F_1\left[\begin{matrix}a,\ b & ; \\ \frac{a+b-33}{2} & ;\end{matrix}\ \frac{1}{2}\right]=(a-b-33)\,{}_2F_1\left[\begin{matrix}a,\ b-1 & ; \\ \frac{a+b-33}{2} & ;\end{matrix}\ \frac{1}{2}\right]+(a-b+33)\,{}_2F_1\left[\begin{matrix}a-1,\ b & ; \\ \frac{a+b-33}{2} & ;\end{matrix}\ \frac{1}{2}\right]$$

Now proceeding the same way of Ref [5] the main result is proved.

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

A Generalization of Fifth and Seventh Order Theta Functions and Their Partial Sums

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GJSFR-A Classification : *FOR Code: 010203, 140302, 140303*

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A Generalization of Fifth and Seventh Order Theta Functions and Their Partial Sums

Bhaskar Srivastava[α], Sameena Saba[Ω]

Abstract - We consider generalized fifth and seventh order mock theta functions and their partial sums. We give relations between these generalized functions and their partial sums.

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I. Introduction

In his last letter to Hardy [6, p 354-355], Ramanujan defined seventeen functions $f(q)$, where $|q| < 1$. He called them mock theta functions for as q radially approaches to the unit circle there is a theta function $f_r(q),\ f(q) - f_r(q) = O(1)$. Ramanujan included in his letter four separate classes of mock theta functions: one class of third order, two of fifth order, and one of seventh order. Watson[9] made extensive study of the third order mock theta functions, because he was able to find representations of these third order mock theta functions under the fundamental transformations of the modular group. However the fifth and the seventh order mock theta functions have been more of a problem. Watson states "I have failed to construct a complete and exact transformation theory of the functions on the lines of the transformation theory of the functions of the third order." Andrews[2] provided for the fifth and the seventh order mock theta functions certain identities for modular forms.

In this paper we consider the generalized fifth and the seventh order mock theta functions defined by Srivastava. He made an extensive study of these generalized functions in his paper [7], [8]. We define and consider partial generalized fifth and seventh order mock theta functions and give expansions of generalized fifth order mock theta functions in terms of the partial generalized mock theta functions. A study of these sums and expansions has been made by Andrews[2]. Earlier Agarwal[1] had showed that one could find a number of partial theta relations by making a systematic study. Andrews has shown that some of these partial theta function identities have some interesting number theoretic interpretations. The above considerations and the interest shown by a number of mathematicians in the study of partial theta function identities motivated us to define "partial" mock theta functions and study their behaviour.

The fifth order mock theta functions of Ramanujan are:

$$f_0(q) = \sum_{n=0}^{\infty} \frac{q^{n^2}}{(-q;q)_n} \ , \qquad \phi_0(q) = \sum_{n=0}^{\infty} q^{n^2} (-q;q^2)_n \ ,$$

$$\psi_0(q) = \sum_{n=0}^{\infty} q^{\frac{(n+1)(n+2)}{2}} (-q;q)_n \ , \qquad F_0(q) = \sum_{n=0}^{\infty} \frac{q^{2n^2}}{(-q;q^2)_n} \ ,$$

$$\chi_0(q) = \sum_{n=0}^{\infty} \frac{q^n (q;q)_n}{(q;q)_{2n}} \ ,$$

And

$$f_1(q) = \sum_{n=0}^{\infty} \frac{q^{n^2+n}}{(-q;q)_n} \ , \qquad \phi_1(q) = \sum_{n=0}^{\infty} q^{(n+1)^2} (-q;q^2)_n \ ,$$

$$\psi_1(q) = \sum_{n=0}^{\infty} q^{\frac{n(n+1)}{2}} (-q;q)_n \ , \quad F_1(q) = \sum_{n=0}^{\infty} \frac{q^{2n(n+1)}}{(q;q^2)_{n+1}} ,$$

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$$\chi_1(q)=\sum_{n=0}^{\infty}\frac{q^n(q;q)_n}{(q;q)_{2n+1}}.$$

And his seventh mock theta functions are:

$$\boldsymbol{F_0}(q)=\sum_{n=0}^{\infty}\frac{q^{n^2}(q;q)_n}{(q;q)_{2n}}\ ,\qquad \boldsymbol{F_1}(q)=1+\sum_{n=0}^{\infty}\frac{q^{n^2}(q;q)_{n-1}}{(q;q)_{2n-1}}$$

$$\boldsymbol{F_2}(q)=\sum_{n=0}^{\infty}\frac{q^{n(n+1)}(q;q)_n}{(q;q)_{2n+1}}.$$

Srivastava generalized these fifth and seventh order mock theta functions.The generalized fifth order mock theta functions are:

$$f_0(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2-3n+n\alpha}z^{2n}}{(-z;q)_n}\ , \tag{1.1}$$

$$\phi_0(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2+n+n\alpha}\left(-\frac{q^3}{z^2};q^2\right)_n}{z^{2n}}, \tag{1.2}$$

$$\psi_0(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=1}^{\infty}\frac{(t)_n q^{\frac{n(n+1)}{2}+n\alpha}\left(-\frac{q^2}{z};q\right)_{n-1}}{z^n}, \tag{1.3}$$

$$F_0(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{2n^2-5n+n\alpha}z^{4n}}{\left(\frac{z^2}{q};q^2\right)_n}, \tag{1.4}$$

$$f_1(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2-2n+n\alpha}z^{2n}}{(-z;q)_n}, \tag{1.5}$$

$$\phi_1(t,z,\alpha;q)=\frac{q^5}{z^4}\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2+3n+n\alpha}\left(-\frac{q^3}{z^2};q^2\right)_n}{z^{2n}}, \tag{1.6}$$

$$\psi_1(t,z,\alpha;q)=\frac{q}{z}\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{\frac{n(n+1)}{2}+n\alpha}\left(-\frac{q^2}{z};q\right)_n}{z^n}, \tag{1.7}$$

$$F_1(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{2n^2-3n+n\alpha}z^{4n}}{\left(\frac{z^2}{q};q^2\right)_{n+1}}, \tag{1.8}$$

$$\chi_0(t,z,\alpha;q)=\frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n\alpha}(z;q)_n}{(z^2q^{-1};q)_{2n}}, \tag{1.9}$$

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$$\chi_1(t,z,\alpha;q) = \frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n\alpha}(z;q)_n}{(z^2q^{-1};q)_{2n+1}}, \tag{1.10}$$

and the generalized seventh order mock theta functions are:

$$\boldsymbol{F_0}(t,z,\alpha;q) = \frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2-3n+n\alpha}(z;q)_n z^{2n}}{\left(\frac{z^2}{q};q\right)_{2n}}, \tag{1.11}$$

$$\boldsymbol{F_1}(t,z,\alpha;q) = 1+\frac{1}{(t)_\infty}\sum_{n=1}^{\infty}\frac{(t)_n q^{n^2-3n+n\alpha}(z;q)_{n-1} z^{2n}}{\left(\frac{z^2}{q};q\right)_{2n-1}}, \tag{1.12}$$

$$\boldsymbol{F_2}(t,z,\alpha;q) = \frac{1}{(t)_\infty}\sum_{n=0}^{\infty}\frac{(t)_n q^{n^2-2n+n\alpha}(z;q)_n z^{2n}}{\left(\frac{z^2}{q};q\right)_{2n+1}}. \tag{1.13}$$

For $t=0, \alpha=1$ and $z=q$ the above generalized functions reduce to Ramanujan"s mock theta functions.

Now we define partial mock theta functions. By taking the partial sums of the series defined in (1.1)-(1.13) from 0 to N, we have the partial generalized mock theta functions of order five and seven as

$$f_{0,N}(t,z,\alpha;q) = \frac{1}{(t)_\infty}\sum_{n=0}^{N}\frac{(t)_n q^{n^2-3n+n\alpha}z^{2n}}{(-z;q)_n}$$

Similarly for the other functions.

II. NOTATION

We shall use the following usual basic hypergeometric notations: For $|q^k|<1$,

$$(a;q^k)_n = (1-a)(1-aq^k)\cdots(1-aq^{k(n-1)}), \quad n\geq 1$$
$$(a;q^k)_0 = 1,$$
$$(a;q^k)_\infty = \prod_{j=0}^{\infty}(1-aq^{kj}),$$

$${}_r\phi_s\left[\begin{matrix}a_1,a_2,\cdots,a_r\\ b_1,\cdots,b_s\end{matrix};q,z\right]_n = \sum_{n=0}^{\infty}\frac{(a_1;q)_n(a_2;q)_n\cdots(a_r;q)_n}{(q;q)_n(b_1;q)_n\cdots(b_s;q)_n}\left[(-1)^n q^{\binom{n}{2}}\right]^{1+s-r} z^n$$

With $\binom{n}{2}=n(n-1)/2$, where $q\neq 0$ when $r>s+1$.

III. A SUMMATION FORMULA AND A GENERAL THEOREM

We shall be using the following identity in developing the expansions. The identity is obtained by simple rearrangement of the series.

$$\sum_{r=0}^{p}\alpha_r\beta_r = \beta_{p+1}\sum_{r=0}^{p}\alpha_r + \sum_{m=0}^{p}(\beta_m-\beta_{m+1})\sum_{r=0}^{m}\alpha_r. \tag{3.1}$$

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Using the summation formula

$$ {}_2\phi_1\begin{bmatrix} a,b,q \\ e,f \end{bmatrix}; q\Bigg]_n = \frac{(q-e)(e-abq)}{(aq-e)(e-bq)}\left[1-\frac{(a,b)_{n+1}}{\left(\frac{e}{q},\frac{abq}{e}\right)_{n+1}}\right] \tag{3.2}$$

and taking in (3.1),

$$\beta_m = \frac{(aq-e)(e-bq)}{(q-e)(e-abq)}\sum_{n=0}^{m-1}\frac{(a,b)_n q^n}{\left(e,\frac{abq^2}{e}\right)_n} = 1-\frac{(a,b)_m}{\left(\frac{e}{q},\frac{abq}{e}\right)_m} \tag{3.3}$$

we finally have

$$\sum_{r=0}^{p}\alpha_r\frac{(a,b)_r}{\left(\frac{e}{q},\frac{abq}{e}\right)_r} = \frac{(a,b)_{p+1}}{\left(\frac{e}{q},\frac{abq}{e}\right)_{p+1}}\sum_{r=0}^{p}\alpha_r - \frac{(aq-e)(e-bq)}{(q-e)(e-abq)}\sum_{m=0}^{p}\frac{(a,b)_m q^m}{\left(e,\frac{abq^2}{e}\right)_m}\sum_{r=0}^{m}\alpha_r . \tag{3.4}$$

IV. Certain Relations Between Mock Theta Functions Of Order Five

In (3.1) putting $\beta_m = \sum_{r=o}^{m-1} q^{\lambda r} = \frac{q^{\lambda m}-1}{q^{\lambda}-1}$, where λ is a positive integer, we get

$$\frac{1}{q^\lambda-1}\sum_{r=0}^{p}\alpha_r\left(q^{\lambda r}-1\right) = \frac{q^{\lambda(p+1)}-1}{q^\lambda-1}\sum_{r=0}^{p}\alpha_r - \sum_{m=0}^{p} q^{\lambda m}\sum_{r=0}^{m}\alpha_r . \tag{4.1}$$

For various values of α_r and taking λ =1 or 2, (4.1) gives several interesting cases.

i. Taking $\alpha_r = \frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r}$ and $\lambda = 1$ in (4.1), we get

$$\sum_{r=0}^{p}\frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r}(1-q^r) = (1-q^{p+1})\sum_{r=0}^{p}\frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r} - (1-q)\sum_{m=}^{p} q^m\sum_{r=0}^{m}\frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r}$$

or

$$\sum_{r=0}^{p}\frac{(t)_r q^{r^2-2r+r\alpha} z^{2r}}{(-z;q)_r} = q^{p+1}\sum_{r=0}^{p}\frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r} + (1-q)\sum_{m=0}^{p} q^m\sum_{r=0}^{m}\frac{(t)_r q^{r^2-3r+r\alpha} z^{2r}}{(-z;q)_r}$$

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which can be written as

$$(1-q)\sum_{m=0}^{p} q^m f_{0,m}(t,z,\alpha;q) = -q^{p+1} f_{0,p}(t,z,\alpha;q) + f_{1,p}(t,z,\alpha;q). \tag{4.2}$$

ii. Taking $\alpha_r = \frac{(t)_r q^{r^2+r+r\alpha}\left(-\frac{q^3}{z^2};q^2\right)_r}{z^{2r}}$ and λ = 2 in (4.1), we get

$$\sum_{m=0}^{p} q^{2m}\,\phi_{0,m}(t,z,\alpha;q)$$
$$= \frac{-q^{2p+2}}{1-q^2}\phi_{0,p}(t,z,\alpha;q) + \frac{z^4}{q^5}\frac{1}{(1-q^2)}\phi_{1,p}(t,z,\alpha;q). \tag{4.3}$$

iii. Taking $\alpha_r = \frac{(t)_r q^{\frac{r^2+r}{2}+r\alpha}\left(-\frac{q^2}{z};q\right)_r}{z^r}$ and in $\lambda = 1$ (4.1), we get

$$\sum_{m=0}^{p} q^{m}\,\psi_{1,m}(t,z,\alpha;q)$$
$$= \frac{-q^{p+1}}{1-q}\psi_{1,p}(t,z,\alpha;q) + \frac{1}{q(1-q)}\psi_{0,p}(t,z,\alpha;q). \tag{4.4}$$

iv. Taking $\alpha_r = \frac{(t)_r q^{r\alpha}(z;q)}{(z^2q^{-1};q)_{2r+1}}$ and $\beta_r = (1-z^2q^{2r-1})$ in (3.1), we get

$$\sum_{m=0}^{p} q^{2m-1}\,\chi_{1,m}(t,z,\alpha;q)$$
$$= \frac{(1-z^2q^{2p+1})}{z^2(1-q^2)}\chi_{1,p}(t,z,\alpha;q) - \frac{1}{z^2(1-q^2)}\chi_{0,p}(t,z,\alpha;q). \tag{4.5}$$

v. Taking $\alpha_r = \frac{q^{2r^2+2r}}{(-q^2;q^2)_r}$, making $q \to q^2$ and setting $a = 0, b = -q^2, e = q^5$ in (3.4), we get

$$\sum_{r=0}^{p} \frac{q^{2r^2+2r}}{(-q^2;q^2)_r}\frac{(-q^2;q^2)_r}{(q^3;q^2)_r} = \frac{(-q^2;q^2)_{p+1}}{(q^3;q^2)_{p+1}}\sum_{r=0}^{p}\frac{q^{2r^2+2r}}{(-q^2;q^2)_r}$$
$$+\frac{q^2(1+q)}{(1-q^3)}\sum_{m=0}^{p}\frac{(-q^2;q^2)_m q^{2m}}{(q^5;q^2)_m}\sum_{r=0}^{m}\frac{q^{2r^2+2r}}{(-q^2;q^2)_r}$$

or

$$\sum_{r=0}^{p} \frac{q^{2r^2+2r}}{(q^3;q^2)_r} = \frac{(-q^2;q^2)_{p+1}}{(q^3;q^2)_{p+1}}\sum_{r=0}^{p}\frac{q^{2r^2+2r}}{(-q^2;q^2)_r}$$
$$+\frac{q^2(1+q)}{(1-q^3)}\sum_{m=0}^{p}\frac{(-q^2;q^2)_m q^{2m}}{(q^5;q^2)_m}\sum_{r=0}^{m}\frac{q^{2r^2+2r}}{(-q^2;q^2)_r}$$

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and we have,

$$(1-q)F_{1,p}(q) = \frac{(-q^2;q^2)_{p+1}}{(q^3;q^2)_{p+1}} f_{1,p}(q^2) + \frac{q^2(1+q)}{(1-q^3)} \sum_{m=0}^{p} \frac{(-q^2;q^2)_m q^{2m}}{(q^5;q^2)_m} f_{1,m}(q^2)\,. \tag{4.6}$$

vi. Taking $\alpha_r = \frac{q^{2r^2+2r}}{(q^3;q^2)_r}, q \to q^2, a = 0, b = q^3, e = -q^4$ in (3.4), we get

$$f_{1,p}(q^2) = \frac{(q^3;q^2)_{p+1}}{(-q^2;q^2)_{p+1}}(1-q)F_{1,p}(q) - \frac{q^2(1-q^2)}{(1+q^2)} \sum_{m=0}^{p} \frac{(q^3;q^2)_m q^{2m}}{(-q^4;q^2)_m} F_{1,m}(q)\,. \tag{4.7}$$

vii. Taking $\alpha_r = \frac{q^{2r^2}}{(-q^2;q^2)_r}, q \to q^2, a = 0, b = -q^2, e = q^3$ and in (3.4), we get

$$F_{0,p}(q) = \frac{(-q^2;q^2)_{p+1}}{(q;q^2)_{p+1}} f_{0,p}(q^2) + \frac{q(1+q)}{(1-q)} \sum_{m=0}^{p} \frac{(-q^2;q^2)_m q^{2m}}{(q^3;q^2)_m} f_{0,m}(q^2). \tag{4.8}$$

viii. Taking $\alpha_r = \frac{q^{2r^2}}{(q;q^2)_r}, q \to q^2, a = 0, b = q, e = -q^4$ and in (3.4), we get

$$f_{0,p}(q^2) = \frac{(q;q^2)_{p+1}}{(-q^2;q^2)_{p+1}} F_{0,p}(q) - \frac{q(1+q)}{(1+q^2)} \sum_{m=0}^{p} \frac{(q;q^2)_m q^{2m}}{(-q^4;q^2)_m} F_{0,m}(q). \tag{4.9}$$

V. Expansions For Seventh Order Mock Theta Functions

i. Taking $\alpha_r = \frac{(t)_r q^{r^2-3r+r\alpha} z^{2r} (z;q)_r}{\left(\frac{z^2}{q};q\right)_{2r+1}}$ and λ = 1 in (4.1), we get

$$\boldsymbol{F_{2,p}}(t,z,\alpha;q) = q^{p+1}\left[\boldsymbol{F_{0,p}}(t,z,\alpha;q) + \boldsymbol{F_{1,p+1}}(t,z,\alpha;q)\right] + (1-q)\sum_{m=0}^{p} q^m \left[\boldsymbol{F_{0,m}}(t,z,\alpha;q) + \boldsymbol{F_{1,m+1}}(t,z,\alpha;q)\right]. \tag{5.1}$$

ii. Taking $\alpha_r = \frac{(t)_r q^{r^2-2r+r\alpha} z^{2r} (z;q)_r}{\left(\frac{z^2}{q};q\right)_{2r+1}}$ and λ = 1 in (4.1), we get

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$$\sum_{m=0}^{p} q^m \boldsymbol{F}_{2,m}(t,z,\alpha;q) = \frac{-q^{p+1}}{(1-q)} \boldsymbol{F}_{2,p}(t,z,\alpha;q) - \frac{q}{(1-q)}\left[1-\boldsymbol{F}_{1,p+1}(t,z,\alpha;q)\right]. \quad (5.2)$$

iii. Taking $\alpha_r = \frac{(t)_r q^{r^2-2r+r\alpha} z^{2r} (z;q)_r}{\left(\frac{z^2}{q};q\right)_{2r+1}}$ and $\beta_r = q^{-r}(1-z^2q^{2r-1})$ in (3.1), we get

$$\boldsymbol{F}_{0,p}(t,z,\alpha;q) = q^{-(p+1)}(1-z^2q^{2p+1})\boldsymbol{F}_{2,p}(t,z,\alpha;q) - \frac{(1-q)}{q}\sum_{m=0}^{p}\frac{(1+z^2q^{2m})}{q^m}\boldsymbol{F}_{2,m}(t,z,\alpha;q). \quad (5.3)$$

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & ISSN: 0975-5896

Chemotherapeutic Values of Four Nigerian Chewing Sticks on Bacteria Isolates of Dental Infection

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Abstract - The invitro phytochemical analysis and antibacterial activities of ethanolic and aqueous crude extracts of four Nigerian chewing sticks (Pseudocedrela kotschyi, Massularia acuminate, Xanthoxylum zanthoxyloides, and Anogeissus schimperi). were investigated. Results of this study showed chewing sticks contained antibacterial agents but the concentration and composition of the active substances differed amongst the plants. Flavonoid and tannin were present in all the plant extracts while alkaloids were absent. The ethanolic crude extracts of the chewing sticks had a greater zone of inhibition (antimicrobial activities) against Staphylococcus aureus, Pseudomonas putida, Bacillus subtilis and Klebsiella spp in comparison with the aqueous extracts.Massularia acuminate exhibited a better antibacterial activity and thus made it more suitable for dental care.

Keywords : Phytochemical, Zone of inhibition, Chewing sticks, antibacterial effects.

GJSFR-G Classification : FOR Code: 040501, 060501

CHEMOTHERAPEUTICVALUESOFFOURNIGERIANCHEWINGSTICKSONBACTERIAISOLATESOFDENTALINFECTION

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Chemotherapeutic Values of Four Nigerian Chewing Sticks on Bacteria Isolates of Dental Infection

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Abstract - The invitro phytochemical analysis and antibacterial activities of ethanolic and aqueous crude extracts of four Nigerian chewing sticks (*Pseudocedrela kotschyi*, *Massularia acuminate*, *Xanthoxylum zanthoxyloides*, and *Anogeissus schimperi*). were investigated. Results of this study showed chewing sticks contained antibacterial agents but the concentration and composition of the active substances differed amongst the plants. Flavonoid and tannin were present in all the plant extracts while alkaloids were absent. The ethanolic crude extracts of the chewing sticks had a greater zone of inhibition (antimicrobial activities) against *Staphylococcus aureus, Pseudomonas putida, Bacillus subtilis and Klebsiella spp* in comparison with the aqueous extracts. *Massularia acuminate* exhibited a better antibacterial activity and thus made it more suitable for dental care.

Keywords : Phytochemical, Zone of inhibition, Chewing sticks, antibacterial effects.

I. Introduction

In Africa, chewing sticks are the most common means of maintaining oral hygiene, and roots, stems and twigs of numerous plants are employed for this purpose. Chewing sticks are recommended for oral hygiene by the World Health Organization, and some of them, or their extracts, are also used in the ethnomedical treatment of oral infections (Ndukwe, Lamikanra and Okeke, 2004). Primary screens have demonstrated that extracts from many chewing sticks have antimicrobial activity against a broad spectrum of microorganisms, including those commonly implicated in orofacial infections (Rotimi *et al.*,1988).

Almost the entire rural population of Nigeria uses chewing sticks for orodental hygiene. Previous studies have demonstrated the antiplaque and antibacterial actions of extracts of these Nigerian chewing sticks (NCS) against oral bacteria, such as *Streptococcus mutans* (Wolinsky and Sote, 1984), *Streptococcus mitis* and oral anaerobes (Rotimi and mosadoni, 1987), which are the organisms commonly implicated in dental caries and orodental infections. Most of the studies on orodental infections stress the importance of oral anaerobes, particularly black-pigmented bacteroides, in the etiology of periodontal diseases (Loesche *et al.*,1985, and Slots, 1982).

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One of the most frequently isolated oral pathogens in these diseases is *Bacteroides gingivalis* (Loesche *et al.*, 1985 and Wolinsky and Sote, 1984), although *Bacteroides melaninogenicus* has also been implicated (Slots, 1982).

Moreso, the choice of chewing sticks to be used in most cases depends on its cleansing action of the teeth; the therapeutic value, or preferred taste or flavour. The sticks (which may be stem or root with bark removed or retained) are cut to convenient lengths and washed thoroughly with fresh water to get rid of the earth or any dirt. The diameter should afford good grip, say between 0.5-1.30cm. Akande and Hayashi (1998) reported that some of the chewing sticks being used are obtained from the following plants: *Garcinia manni, Masularia accuminita, Terminalia glaucescens, Anogeissus leiocarpus, Pseudocedrela kotschyi, Xanthoxyllum gilletti* and *Azadiracta indica.* Investigations carried out on some of these chewing sticks showed that they posses antimicrobial activity against oral microbial flora such as *Staphylococcus aureus* and *S. auricularis* (Akande and Hayashi ,1998), *Candida albicans, Aspergillus flavus, Microsporium gypseum* and *Trichophyton metagrophytes* (Adekunle and Odukoya, 2006).

It must be stressed that the development of virile herbal toothpaste is consequent upon the bioactivity of the constituent chewsticks against a wide range of oral pathogens. Hence the aim of this paper is to report the antimicrobial activity of the ethanolic and aqueous extracts of four Nigerian chewing sticks; *Pseudocedrela kotschyi*, *Massularia acuminate*, *Xanthoxylum zanthoxyloides*, and *Anogeissus schimperi* on oral bacteria pathogens such as *Staphylococcus aureus, Pseudomonas putida, Bacillus subtilis and Klebsiella spp*.

II. Materials and Methods

Sources of Plant Materials : The plant species (chewing stick) used for these research work were *Pseudocedrela kotschyi* (Emi gbegi), *Massularia Acuminata* (Udi) *Xanthoxylum zanthozyloides* (orin ata) and *Anogeissus schimperi* (pako dudu). They were purchased from the Emir's market, Ilorin Kwara State, Nigeria. The plants species were authenticated by a botanist at the Department of Botany University of Ilorin

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and Department of Biology Kwara State Polytechnic Ilorin, Nigeria.

Source of Microorganism : Pure clinical isolates of *Staphylococcus aureus*, *Pseudomonas putida*, *Bacillus subtilis* and *Klebsiella spp* isolated from patient with dental diseases were collected from the Bacteriology department, University of Ilorin Teaching Hospital. The bacteria were stored on Nutrient agar (NA) slants in the refrigerator at 4^{0}C prior to use.

Extract Preparation : The ethanolic and aqueous extracts were prepared using modifications method of Ogundiya, Okunade and kolapo (2008). The root and branch of the test plants were well dried in the laboratory and then grinded to powder. About 25g of the powder were separately soaked in 125ml of 95% ethanol in a 250ml reagent bottle and stoppered. This was allowed to stand for 3 days to permit full extraction of the active ingredients. The fluids were then filtered using Whatman No1 filter paper. The extracts were rotary dried to obtain the concentrate. It was then kept in fridge prior to use. A 2.0g/l solution of each extract was prepared and fractionated into 0.4g/l, 0.2g/l and 0.1g/l concentrations needed for the bioassay.

Preliminary Phytochemical Studies: Phytochemi -cal studies were carried out using methods described by Fadeyi *et al.* (1987) and Harbone (1998). Basic phytochemical screening tests (anthocyanin, anthraquinone, alkaloids, flavonoids, phlobatannin, saponin,, steroid and tannin) were carried out on both ethanolic and aqueous extracts.

Antimicrobial Susceptibility Bioassay : The ditch plate method (Al-bagieh and Almas, 2007) was used to test the antimicrobial activity. Three to four colonies of the microorganisms were suspended in 3 ml of sterile normal saline and a lawn culture was produced on the Mueller Hinton agar . 0.1 ml aliquots of the miswak extract were pipetted into the ditches made at the center of petri dishes under sterile conditions. The plates were left for 1 hr at room temperature and then incubated at 37°C for 48 hours and examined for inhibition zones of the growth of bacteria around the extract. It was done in triplate. The average of those zones were recorded in milliliters.

Determination of the Minimum Inhibitory Concentrations (MIC's) of the Extracts

Serial dilution was carried out to give final concentration between 1.56 and 50mg crude extract per milliliter. The tubes were inoculated with 10μl of the bacterial suspension per milliliter nutrient broth equivalent to 0.5 McFarland standards and incubated at 37^{0}C for 24 hours (Zakaria et al., 2007)

III. Results and Discussion

Both ethanolic and aqueous water extracts of each of the chewing sticks inhibited the growth of all the species of bacteria tested, except the extract of *Anogeissus schimperi* which has no pharmaceutical effects on *Pseudomonas putida* (figure 1 and 2). The no activity of all the extracts of the tested chewing sticks may be suggesting that these plant species contained no phytochemical active or that the method of extraction did not yield any compounds with pharmaceutical effect against the isolate (Adekunle and Odukoya, 2006). This observation is supported by Valenciennes *et al* (2001) who reported that antifungal agents might not necessarily be antibacterial. The ethanolic crude extracts of the chewing sticks had a greater pharmaceutical effects in comparison with the aqueous extract, which might be because the bioactive components were more soluble in ethanol (Rotimi and Mosadoni, 1987). *Massularia accuminata* was the most active against the bacteria species tested, since it exhibited the highest antibacterial inhibition among the plant extracts as reported by Barnabas and Nagarajan (1988). In fact it is claimed locally that the use of M. accuminata might reduce or completely stop mouth odour.. The control which was sterilized distilled water instead of plant extracts yield no zone of inhibition. (*Pseudocedrela kotschyi*, *Massularia acuminate*, *Xanthoxylum zanthoxyloides*, and *Anogeissus schimperi*).

The determination of the minimum inhibitory concentration (MIC) of the mutagenic agent, acridine orange was to provide a minimum concentration (sub-MIC) of the extracts that would selectively bind to susceptible agents. The minimum inhibitory concentration (MIC) of the ethanol extracts of *Pseudocedrela kotschyi*, *Massularia acuminate*, *Xanthoxylum zanthoxyloides*, and *Anogeissus schimperi* ranged between 1.56 mg/ml and 6.25 mg/ml as shown in Figure 3. *Pseudomonas putida* had MIC of 3.13 mg/ml in all plant extract studied while all organisms studied had MIC of 3.13mg/ml for *Pseudocedrela kotschyi* and *Staphylococcus aureus* had the least MIC of 1.56mg/ml for *Anogeissus schimperi*.

Table 3 shows the phytochemical compounds present in the aqueous and ethanolic crude extract of four plants. Flavonoids was present in all four extract. Tannin was present in all the extract except in the aqueous and ethanolic extracts of *Anogeissus Schimperi*, which probably accounted for its low potent pharmaceutical activities even though Ugoji *et al* (2000) reported that aqueous extracts contain antibacterial substances. Burapadaja and Bunchoo (1995) reported the presence of Tannins in *Terminalia citriana* extracts and explained that the tannins inhibited cell wall formation in bacteria leading to the death of the microorganism. Alkanoid was absent in all of the plant extract.

IV. Conclusion and Recommendation

The results presented in this study showed that the tested chewing sticks actually contained

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antibacterial (pharmaceutical) compounds. In addition, the results revealed that the antimicrobial activities of the tested chewing sticks vary and are target-microbe specific. The concentration and composition of the bioactive substance may differ from one part to another as indicate in the degree of potency and presence of photochemical compounds. The regular use of Nigeria chewing sticks may decrease the incidence of dental disease cause by microbes. Chewing stick from *Massularia accuminata* (udi) is therefore recommended for good oral health due to its higher antibacterial properties.

Figures And Tables

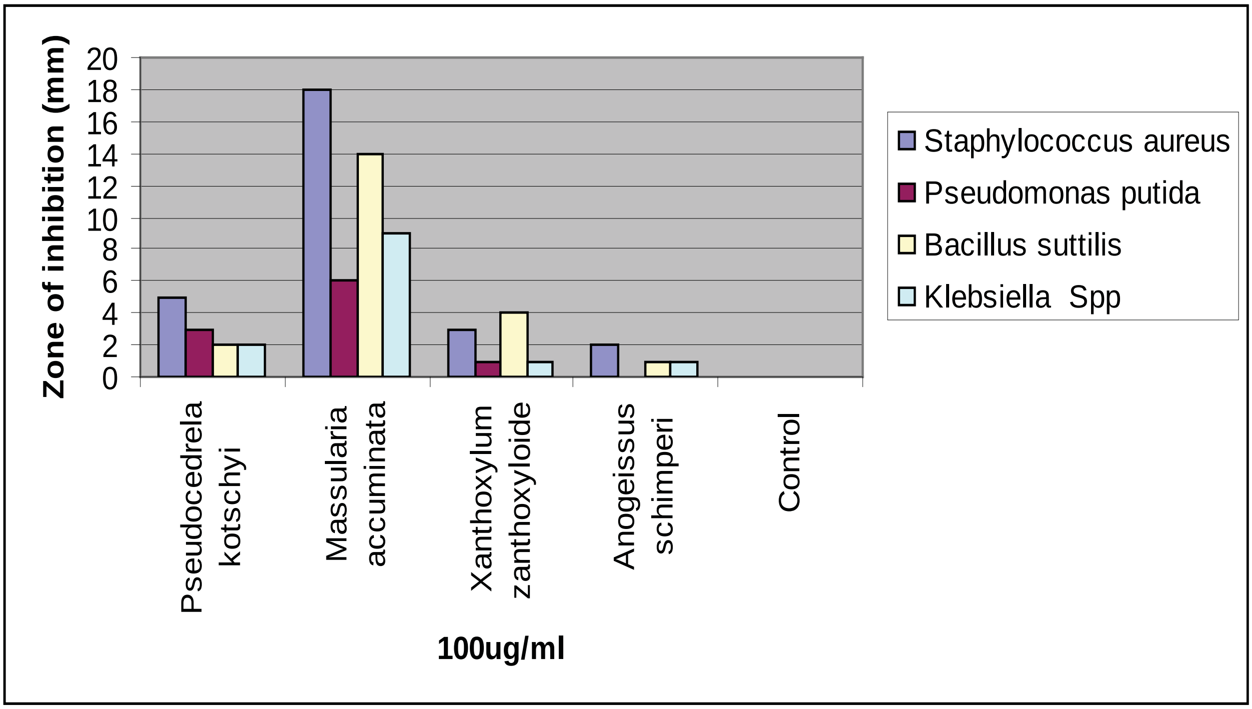

Figure1: Chemotherapeutic values of ethanolic crude extracts of chewing sticks

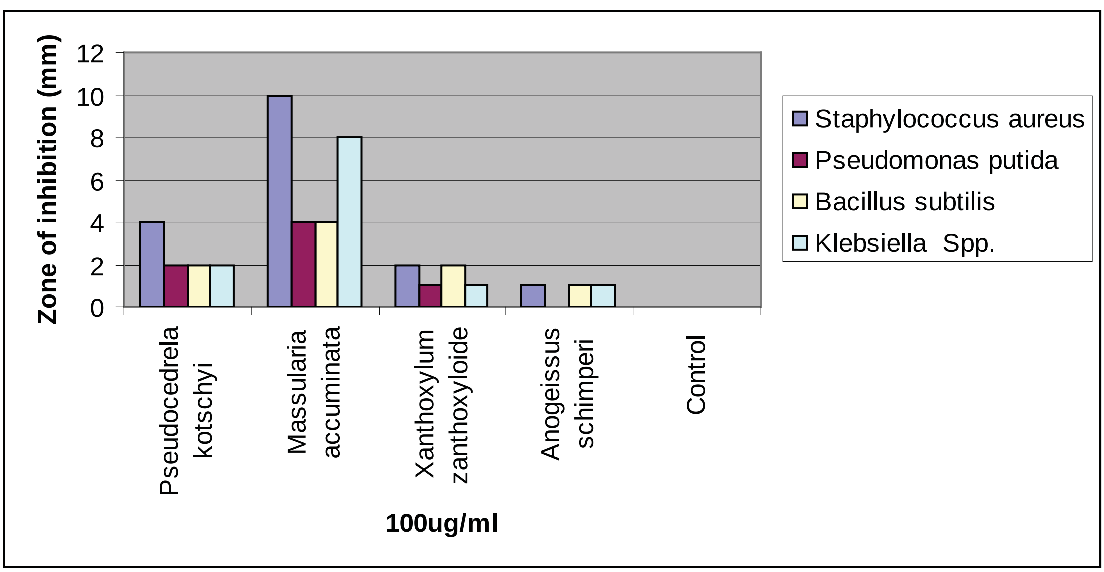

Figure 2 : Chemotherapeutic values of aqueous crude extracts of chewing sticks

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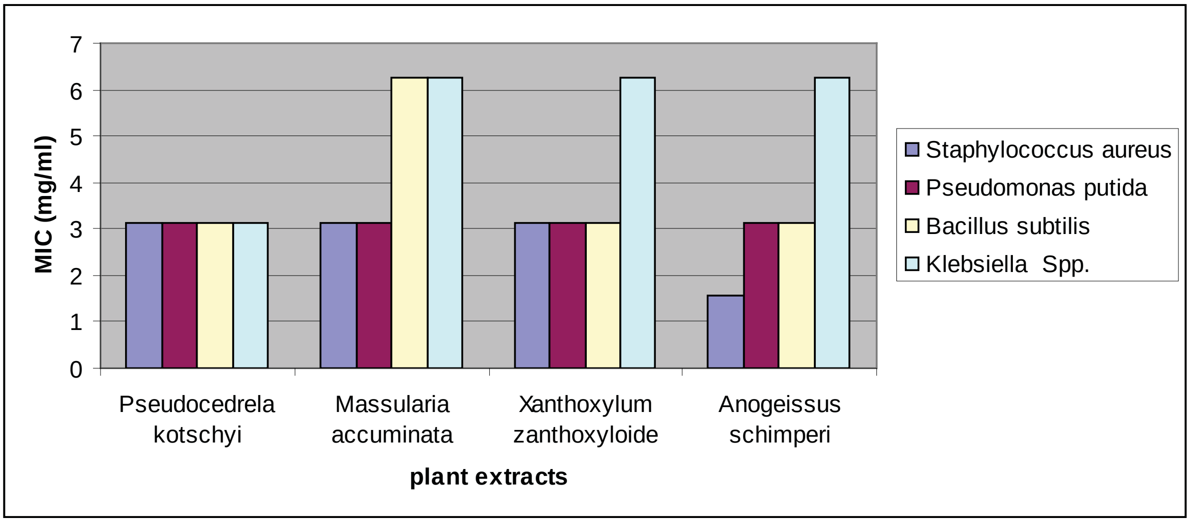

Figure 3 : Minimum inhibitory concentration of chewing sticks (plant extracts)

Table 1 : Phytochemical Compound In The Crude Extracts Of Four Nigerian Chewing Sticks

Sample extract (100µg/ml)	Alkaloid	Antraquninone	Antocyanin	Flavonoids	Phlobatannin	Saponin	Steroid	Tannin
Pseudocedrela kotschyi								
Aqueous	-	-	-	+	+	-	-	+
Ethanol	-	+	+	+	+	+	+	+
Massularia accuminata								
Aqueous	-	-	+	+	-	+	-	+
Ethanol	-	+	+	+	-	+	+	+
Xanthoxylum zanthoxyloide								
Aqueous	-	-	-	+	+	+	-	+
Ethanol	-	-	+	+	+	+	+	+
Anogeissus Schimperi								
Aqueous	-	-	-	+	+	-	+	-
Ethanol	-	+	+	+	+	+	+	-

Key : (+) Presence of the phytochemical compound
(-) Absence of the phytochemical compound

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Global Journal of Science Frontier Research
Volume 11 Issue 8 Version 1.0 November 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN : 2249-4626 & Print ISSN: 0975-5896

Heat and mass transfer for Soret and Dufour's effect on mixed convection boundary layer flow over a stretching vertical surface in a porous medium filled with a viscoelastic fluid in the presence of magnetic field

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Abstract - Thermal-diffusion and diffusion-thermo effects on combined heat and mass transfer on mixed convection boundary layer flow over a stretching vertical surface in a porous medium filled with a viscoelastic fluid in the presence of magnetic field is investigated. The partial differential equations governing the problem have been transformed by a similarity transformation into a system of ordinary differential equations which are solved numerically by using the shooting method with sixth-order of Runge-Kutta technique which are compared with Homotopy Adomian's Decomposition Method (HAM) for special case when magnetic field parameter is zero For fluids of medium molecular weight (H2, air), profiles of the dimensionless velocity, temperature and concentration distributions are shown graphically for various values of parameters embedded in the flow model. Finally, numerical values of physical quantities, such as the local skin friction coefficient, the local Nusselt number and the local Sherwood number are presented in tabular form.

Keywords : *Heat transfer; Soret effect: Dufour effect: Shooting method: viscoelastic fluid: magnetic field.*

GJSFR-A Classification : *FOR Code: 020404, 020304, 020303*

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Heat and mass transfer for Soret and Dufour's effect on mixed convection boundary layer flow over a stretching vertical surface in a porous medium filled with a viscoelastic fluid in the presence of magnetic field

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I. Introduction

The problem of steady hydromagnetic flow and heat transfer over a stretching surface could be very practicable in many applications in the polymer technology and metallurgy. In particularly, many metallurgical processes involve the cooling of continuous strips or filaments by drawing them though a quiescent fluid and that in the process of drawing, these strips are sometimes stretched. In the case of annealing and thinning of copper wires, the properties of the final product depend to a great extent on the rate of cooling. By drawing such strips in an electrically conducting fluid subject to a magnetic field, the rate of cooling can be controlled and final products of desired characteristics might be achieved [1]. Also, in several engineering processes, materials manufactured by extrusions processes and heat treated materials traveling between a feed roll and a wind up roll on convey belts possess the characteristics of a moving continuous surface. The steady flow on a moving continuous flat surface was first considered by Sakiadis [2] who developed a numerical solution using a similarity transformation. Chiam [3] reported solutions for steady hydromagnetic flow over a surface stretching with a power law velocity with the distance along the surface. In many studies Soret and Dufour effects are neglected, on the basis that they are of a smaller order of magnitude than the effects described by Fourier's and Fick's laws. There are, however, exceptions. Eckert and Drake [4] have presented several cases when the Dufour effect cannot be neglected. Platten and Legros [5] state that in most liquid mixtures the Dufour effect is in operate, but that this may not be the case in gases. Benano-Molly et al. [6] have studied the problem of thermal diffusion in binary fluid, lying within a porous medium and subjected to a horizontal thermal gradient and have shown that multiple convection-roll flow patterns can develop depending on the values of the Soret number. They concluded that for saturated porous media, the phenomenon of cross diffusion is further complicated because of the interaction between the fluid and the porous matrix and because accurate values of the cross diffusion coefficients are not available. However, Soret and Dufour effects have been found appreciably influence the flow field in free convection boundary layer over a vertical surface embedded in a fluid-saturated porous medium.

Alan and Rahman [7], examined Dufour and Soret effects on mixed convection flow past a vertical porous flat plate with variable suction embedded in a porous medium for a hydrogen-air mixture as the non-chemical reacting fluid pair. Gaikwad et al. [8], investigated the onset of double diffusive convection in a two component couple stress fluid layer with Soret and Dufour effects using both linear and non-linear stability analysis. Emmanuel et al. [9] studied

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numerically the effect of thermal-diffusion and diffusion-thermo on combined heat and mass transfer of a steady hydromagnetic convective and slip flow due to a rotating disk with viscous dissipation and Ohmic heating. Anwar et al. [10] examined the combined effects of Soret and Dufour diffusion and porous impedance on laminar magneto-hydrodynamic mixed convection heat and mass transfer of an electrically-conducting, Newtonian, Boussinesq fluid from a vertical stretching surface in a Darcian porous medium under uniform transverse magnetic field. Nithyadevi and Yang [11] investigated numerically the effect of double-diffusive natural convection of water in a partially heated enclosure with Soret and Dufour coefficients around the density maximum. Recently, Olanrewaju [12] examined Dufour and Soret Effects of a transient free convective flow with radiative heat transfer past a flat plate moving through a binary mixture. Osalusi et al [13], investigated thermal-diffusion and diffusion-thermo effects on combined heat and mass transfer of a steady MHD convective and slip flow due to a rotating disk with viscous dissipation and Ohmic heating. Anwar Beg et al [14] examined the numerical study of a free convection magnetohydrodynamic heat and mass transfer from a stretching surface to a saturated porous medium with Soret and Dufour effects. Afify [15] studied the similarity solution in MHD: Effects of thermal diffusion and diffusion thermo on free convective heat and mass transfer over a stretching surface considering suction or injection. More recently, Hayat et al. [16], investigated heat and mass transfer for Soret and Dufour's effect on mixed convection boundary layer flow over a stretching vertical surface in a porous medium filled with a viscoelastic fluid.

The aim of this study is to investigate the steady mixed convection boundary layer flow due to the combined effect of heat and mass transfer over a stretched vertical surface in a porous medium filled with a viscoelastic fluid under Soret and Dufour's effects in the presence of magnetic field. It is interesting to note that Hayat et al. [16] is a special case in this present study. To the best of the author's knowledge, this problem has not been considered before.

II. Mathematical Models

We consider the heat and mass transfer flow due to stretching of a heated or cooled vertical surface of variable temperature $T_w(x)$ and variable concentration $C_w(x)$ in a porous medium filled with a viscoelastic fluid of uniform ambient temperature T_∞ and uniform ambient concentration C_∞. It is assumed that the surface is stretched in its plane with velocity $u_w(x)$. The density variation and the buoyancy effects are taken into consideration, so that the Boussinesq approximation for both the temperature and concentration gradient can be adopted. In addition the Soret and Dufour effects are considered in the presence of magnetic field. In the absence of heat generation and viscous dissipation, the steady boundary Layer equations are given by [17],

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0, \tag{1}$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\upsilon\frac{\partial^2 u}{\partial y^2}+k_0\left(u\frac{\partial^3 u}{\partial x\partial y^2}+\frac{\partial u\partial^2 u}{\partial x\partial y^2}+\frac{\partial u\partial^2 u}{\partial y\partial y^2}+\upsilon\frac{\partial^3 u}{\partial y^3}\right)-u\frac{\upsilon}{K}-u\frac{\sigma B_0^2}{\rho} + g\beta_T(T-T_\infty)+g\beta_C(C-C_\infty), \tag{2}$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha_m\frac{\partial^2 T}{\partial y^2}+\frac{D_e k_T}{c_s c_p}\frac{\partial^2 C}{\partial y^2}, \tag{3}$$

$$u\frac{\partial C}{\partial x}+v\frac{\partial C}{\partial y}=D_e\frac{\partial^2 C}{\partial y^2}+\frac{D_e k_T}{T_m}\frac{\partial^2 T}{\partial y^2}. \tag{4}$$

The boundary conditions at the sheet (wall) and in the free stream are:

$$\begin{gathered} u=U_w(x)=ax, \quad v=0,\ T=T_w(x)=T_\infty+bx,\ C=C_w(x)=C_\infty+cx \ \ at \ \ y=0, \\ u\to 0,\ \frac{\partial u}{\partial y}\to 0,\ T\to T_\infty,\ C\to C_\infty \ \ as \ \ y\to\infty, \end{gathered} \tag{5}$$

where u and v denote the velocity components in the x- and y- directions respectively, T is the fluid temperature, g is the acceleration due to gravity, α is the thermal diffusivity, β_T is the coefficient of thermal expansion, β_C is the coefficient of concentration expansion, σ is the electrical conductivity of the fluid, B_0 is the externally imposed magnetic field strength in the y-direction, ρ is the density of the fluid, T_∞ is the

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free stream temperature, C_∞ is the free stream concentration of the species, D_m is the mass diffusivity, c_p is the specific heat capacity, c_s is the concentration susceptibility, T_m is the mean fluid temperature and k_0 is the viscoelastic parameter. Further $a(>0)$, b and $c(>0)$ are constants with $b>0$ for a heated plate ($T_w > T_\infty$) and b<0 for a cooled surface ($T_w < T_\infty$), respectively.

The governing equations can be transformed by introducing a dimensionless stream functions with the following similarity variables

$$\psi = x\sqrt{a\upsilon}\, f(\eta),\quad \theta(\eta)=\frac{T-T_\infty}{T_w-T_\infty},\ \phi(\eta)=\frac{C-C_\infty}{C_w-C_\infty}, \eta=\sqrt{\frac{a}{\upsilon}}y. \tag{6}$$

Putting Eq. (6) into Eqs. (2)-(4), we have the following ordinary differential equations

$$F''' + FF'' - F'^2 - K\left(FF^{iv} - 2F'F''' + F''^2\right) - \gamma F' - \delta F' + \lambda(\theta + N\phi) = 0, \tag{7}$$

$$\theta'' + \Pr\theta' - \Pr\theta F' + Du\phi'' = 0, \tag{8}$$

$$\phi'' + \Pr Le\left(F\phi' - \phi F'\right) + SrLe\theta'' = 0, \tag{9}$$

$$\begin{gathered} F(0)=0,\quad F'(0)=1,\quad \theta(0)=1,\ \phi(0)=1, \\ F'(\infty)\to 0,\quad F''(\infty)\to 0,\quad \theta(\infty)\to 0,\quad \phi(\infty)\to 0. \end{gathered} \tag{10}$$

Here $Pr = \upsilon/\alpha_m$ is the Prandtl number, $Le = \alpha_m/D_e$ is the Lewis number, λ is the constant dimensionless mixed convection parameter, $K(\geq 0)$ is the dimensionless viscoelastic parameter, N is the constant dimensionless concentration buoyancy parameter, γ is the constant dimensionless porosity parameter, δ is the constant dimensionless magnetic field parameter, Du is the Dufour number and Sr is the Soret number, which are defined as

$$\begin{gathered} \delta=\frac{\sigma B_0^2}{\rho a},\quad \gamma=\frac{\upsilon}{aK},\quad \lambda=\frac{Gr_x}{\mathrm{Re}_x^2},\quad K=\frac{k_0 a}{\upsilon},\quad N=\frac{\beta_C(C_w-C_\infty)}{\beta_T(T_w-T_\infty)}, \\ Du=\frac{D_e k_T(C_w-C_\infty)}{c_s c_p(T_w-T_\infty)},\qquad Sr=\frac{D_e k_T(T_w=T_\infty)}{T_m\alpha_m(C_w-C_\infty)}, \end{gathered} \tag{11}$$

with $Gr_x = g\beta_T(T_w-T_\infty)x^3/\upsilon^2$ being the local Grashof number and $\mathrm{Re}_x = u_w x/\upsilon$ is the local Reynolds number.

III. Numerical Procedure

The set of non-linear ordinary differential equations (7)–(9) with boundary conditions in (10) have been solved numerically by using the Runge–Kutta integration scheme with a modified version of the Newton–Raphson shooting method with γ, K, N, Pr, Le, Du, Sr, δ and λ as prescribed parameters. The computations were done by a program which uses a symbolic and computational computer language MAPLE [18]. A step size of $\Delta\eta = 0.001$ was selected to be satisfactory for a convergence criterion of 10^{-7} in nearly all cases. The value of y_∞ was found to each iteration loop by the assignment statement $\eta_\infty = \eta_\infty + \Delta\eta$. The maximum value of η_∞, to each group of parameters γ, K, N, Pr, Le, Du, Sr, δ and λ is determined when the values of unknown boundary conditions at $\eta = 0$ not change to successful loop with error less than 10^{-7}.

IV. Results and Discussion

Here, we assigned physically realistic numerical values to the embedded parameters in the system in order to gain an insight into the flow structure with respect to velocity, temperature and concentration profiles. In all computations we desire the variation of $F', \theta, and\ \phi$ versus η for the velocity, temperature and species diffusion boundary layers. Table (1) and (2)shows the comparison of Hayat et al [16] work with $\delta = 0$ and it is noteworthy that there is an agreement despite the fact that Hayat et al. [12] used HAM which gives a closed form solution. The values of skin friction coefficient, the local Nusselt number and the local Sherwood number for various values of embedded parameters are shown in table (1). It is

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clearly seen that $\lambda>0$ corresponds to assisting flow (heated plate), $\lambda<0$ corresponds to opposing flow (cooled plate) and $\lambda=0$ corresponds to forced convection flow, respectively. It must also be noticed that N can take positive values, negative values and N can be zero (mass transfer is absent). We further notice that increasing Pr, Sr and δ parameters leads to an increase in the concentration boundary layer thickness while increasing in λ, Du and Le resulted into shear thinning of the boundary layer. Finally, we observed that the flow field is appreciably influenced by the Dufour and Soret effects.

Table 1 : Computations showing comparison of $-F''(0), -\theta'(0)$ *and* $-\phi'(0)$ with Hayat et al. [12].

									Present	Present	Present	Hayat et al. [16]	Hayat et al. [16]	Hayat et al. [16]
K	***γ***	***λ***	***N***	***Pr***	***Du***	***Le***	***Sr***	***δ***	$-F''(0)$	$-\theta'(0)$	$-\phi'(0)$	$-F''(0)$	$-\theta'(0)$	$-\phi'(0)$
0	2	1	-0.2	1	0.1	1	0.2	0	1.4148	0.8657	0.8034	1.4148	0.8657	0.8034
0.2	2	1	-0.2	1	0.1	1	0.2	0	1.2949	0.8865	0.8235	1.2949	0.8865	0.8235
0.4	2	1	-0.2	1	0.1	1	0.2	0	1.2065	0.9030	0.8397	1.2065	0.9030	0.8397
0.1	0	1	-0.2	1	0.1	1	0.2	0	0.7466	1.0023	0.9379	0.7466	1.0023	0.9379
0.1	1	1	-0.2	1	0.1	1	0.2	0	1.0298	0.9417	0.8778	1.0298	0.9417	0.8778
0.1	2	1	-0.2	1	0.1	1	0.2	0	1.3498	0.8767	0.8140	1.3498	0.8767	0.8140
0.1	3	1	-0.2	1	0.1	1	0.2	0	1.5463	0.8435	0.7813	-	-	-
0.1	1	0	-0.2	1	0.1	1	0.2	0	1.3484	0.8551	0.7916	1.3484	0.8551	0.7916
0.1	1	1	-0.2	1	0.1	1	0.2	0	1.0298	0.9417	0.8778	1.0298	0.9417	0.8778
0.1	1	2	-0.2	1	0.1	1	0.2	0	0.7524	0.9937	0.9291	0.7524	0.9937	0.9291
0.1	1	1	-0.5	0.7	0.1	1	0.2	0	1.1261	0.7478	0.6758	1.1261	0.7478	0.6758
0.1	1	1	-0.5	1.2	0.1	1	0.2	0	1.1567	1.0106	0.9545	1.1567	1.0106	0.9545
0.1	1	1	-0.5	1.7	0.1	1	0.2	0	1.1742	1.2151	1.1899	1.1742	1.2151	1.1899
0.1	1	1	-0.5	1	0.3	1	0.2	0	1.1205	0.8155	0.8805	1.1205	0.8155	0.8805
0.1	1	1	-0.5	1	0.5	1	0.2	0	1.0950	0.7103	0.9102	1.0950	0.7103	0.9102
0.1	1	1	-0.5	1	0.7	1	0.2	0	1.0700	0.5975	0.9397	1.0700	0.5975	0.9397
0.1	1	1	-0.5	1	0.1	1.2	0.2	0	1.1344	0.9976	0.9604	1.1344	0.9976	0.9604
0.1	1	1	-0.5	1	0.1	1.5	0.2	0	1.1201	0.9070	1.1082	1.1201	0.9070	1.1082
0.1	1	1	-0.5	1	0.1	1.7	0.2	0	1.1125	0.9030	1.1981	1.1125	0.9030	1.1981
0.1	1	1	-0.5	1	0.1	1.7	0.2	0	1.1125	0.9030	1.1981	1.1125	0.9030	1.1981
0.1	1	1	-0.5	1	0.1	1	0.4	0	1.1296	0.9091	1.0174	1.1296	0.9091	1.0174
0.1	1	1	-0.5	1	0.1	1	0.6	0	1.1475	0.9153	0.8277	1.1475	0.9153	0.8277
0.1	1	1	-0.5	1	0.1	1	0.2	1	1.0760	0.9144	0.8505	-	-	-
0.1	1	1	-0.5	1	0.1	1	0.2	2	1.3831	0.8566	0.7940	-	-	-
0.1	1	1	-0.5	1	0.1	1	0.2	3	1.6472	0.8092	0.7481	-	-	-

Table 2 : Comparison of value of $-\theta'(0)$ for some values of Pr when $\lambda=K=Du=\delta=0$, $\gamma=1$, $N=-0.5$, $Le=1$, $Sr=0.2$

Pr	Hayat et al.[16]	Present results
0.01	0.01977	0.019772
0.72	0.80863	0.808631
1	1.00000	1.000001
3	1.92374	1.923744
10	3.72075	3.720753

a) Velocity Profiles

Figures 1-6 depict the effects of emerging flow parameters on non-dimensional velocity profiles. Figure 1 depicts the influence of Dufour number on the velocity boundary layer and it was observed that increase Dufour number brings a slight increase in the fluid velocity. In figure 2, it is observed that increasing the porosity parameter lead to decrease in the fluid velocity which resulted to velocity boundary layer thinning. Figure 3, It is clearly seen that $\lambda>0$ corresponds to assisting flow (heated plate). Increase in the mixed convection parameter leads to an increase in the fluid velocity. It is clearly seen in figure 4 that the effect of increasing the magnetic field strength on the momentum boundary-layer thickness is illustrated. Increasing this parameter lead to a decrease in the velocity which confirmed with the fact that the magnetic field presents a damping effect on the velocity by creating a drag force that opposes the fluid motion. Figure 5 display the solution of velocity profiles across the boundary layer for different values of dimensionless viscoelastic parameter K and it was observed that increasing the value of K leads to an increase in the fluid velocity and thereby thickening the

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velocity boundary layer. Finally, in figure 6, we display the solution of the velocity profiles for various values of the dimensionless concentration buoyancy parameter. If $N < 0$, then it slows down the fluid velocity but if $N > 0$, the fluid velocity increases.

b) Temperature Profiles

Figures 7-15 depicts the effects of embedded parameters in the flow on non-dimensional temperature profiles. Figure 7 display the variations of Prandtl number (Pr) on the temperature. The thermal boundary layer thickness is found to decrease upon increasing the Prandtl number. It is reasonable in the sense that larger Prandtl number corresponds to the weaker thermal diffusivity and thinner boundary layer. In figures 8 and 9, we observed that increase in Lewis number (Le) and Soret number (Sr) has little effect on the fluid temperature. Increasing Dufour number (Du) lead to an increase in the fluid temperature (see figure 10). In figure 11, we display the solution of temperature profiles across the boundary layer thickness for different values of dimensionless porosity parameter (γ) and we noticed that increasing this porosity leads to an increase in the fluid temperature. However temperature and the thermal boundary layer thickness increase for large value of γ. The effect of λ on the temperature is analyzed in figure 12. It is observed that temperature and the thermal boundary layer thickness decrease when λ is increased. In figure 13, we display the influence of magnetic parameter (δ) on the temperature of the system. Increasing δ lead to an increase in the fluid temperature which resulted to the thermal boundary layer thickening. Figure 14 depicts the solution of the temperature profiles for various values of dimensionless viscoelastic parameter (K). It is interesting to note that increasing viscoelastic parameter decreases the fluid temperature. Finally, in figure 15, we display the solution of the temperature profiles for various values of the dimensionless concentration buoyancy parameter N at it was observed that whenever $N > 0$, the thermal boundary layer thickness decreases and increases whenever $N < 0$.

c) Concentration Profiles

The effects of embedded parameters on concentration field ϕ are discussed in Figures 16-24. It is clearly seen that the behavior of K and γ on the concentration field is opposite to that of temperature field which is obvious from figures 23 and 20. It is interesting to note that the effects of λ and Pr on the temperature and concentration profiles are similar (Figures 21 and 16). In figure 17, we display the solution of concentration profile for various values of Lewis number (Le). The effect of Lewis number on the concentration profile is as Le gradually increases, this corresponds to the weaker molecular diffusivity and thinner boundary layer thickness. The effect of Dufour and Soret number on the concentration field is found in figures 19 and 18. Increasing Dufour number leads to a small decrease in the concentration boundary layer thickness while increasing the Soret number increases the concentration boundary layer thickness. It is noticed that the behavior of Du and Sr on the temperature and concentration fields is opposite. Similarly, in figure 22, the effect of increasing the imposed magnetic field strength δ on the concentration field is to increase the concentration boundary layer thickness. Finally, in figure 15, we display the solution of the concentration profiles for various values of the dimensionless concentration buoyancy parameter N at it was observed that whenever $N > 0$, the thermal boundary layer thickness decreases and increases whenever $N < 0$ as in the case of the concentration fields.

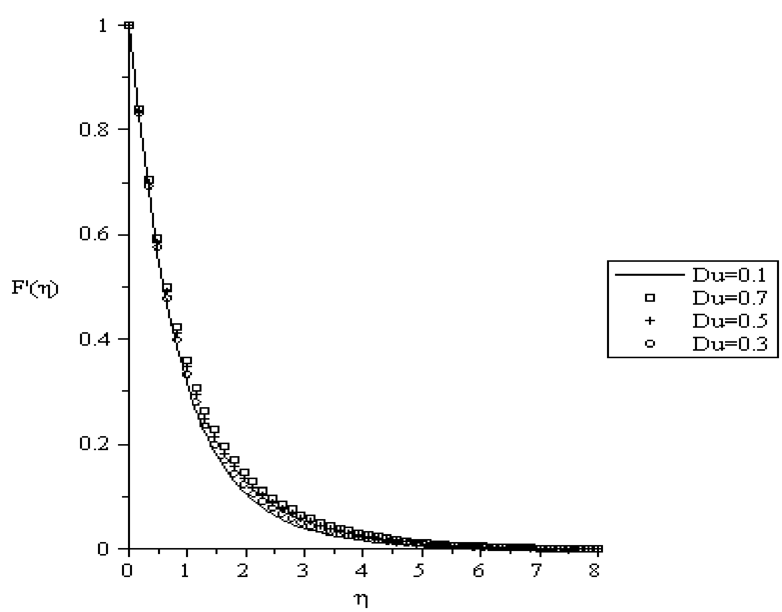

Figure 1 : Velocity profiles for $\gamma=2$, $\lambda=1$, $\delta=0.1$, $K=0.1$, $Sr=0.1$, $Pr=1$, $Le=1$, $N=-0.1$

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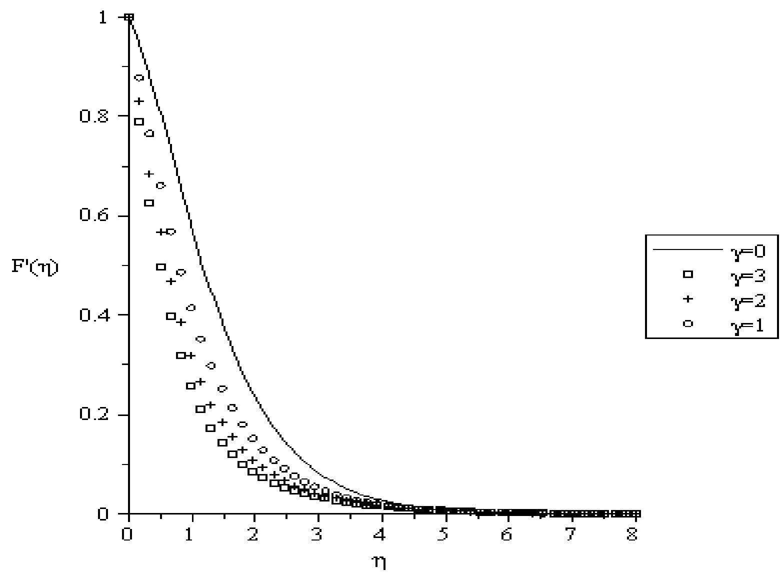

Figure 2 : Velocity profiles for Du=0.1, λ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

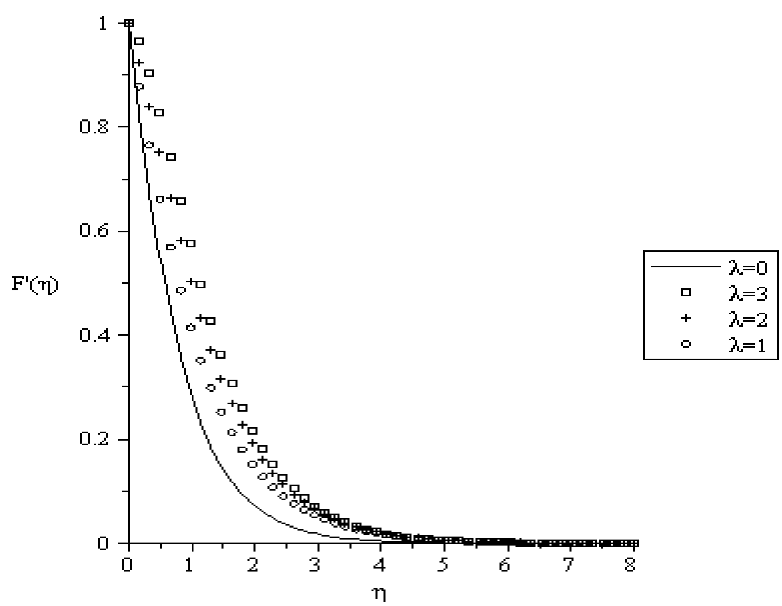

Figure 3 : Velocity profiles for Du=0.1, γ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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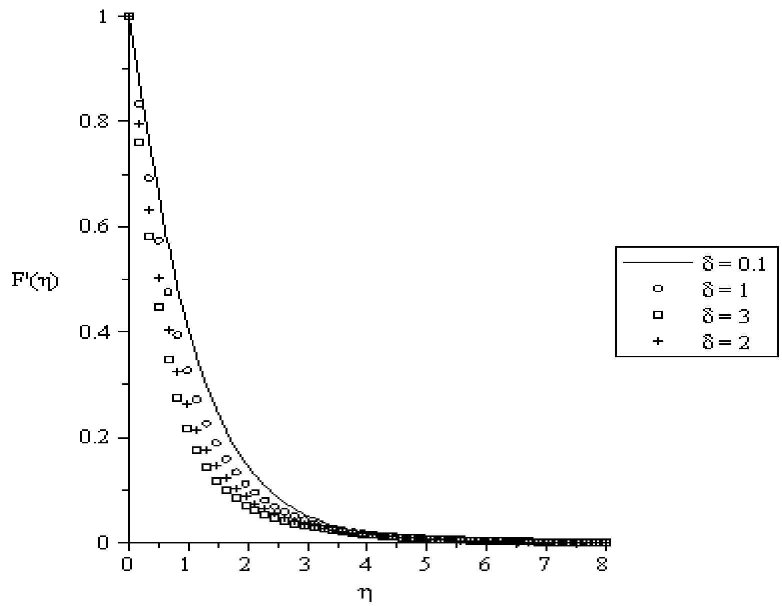

Figure 4 : Velocity profiles for Du=0.1, γ=1, λ=1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

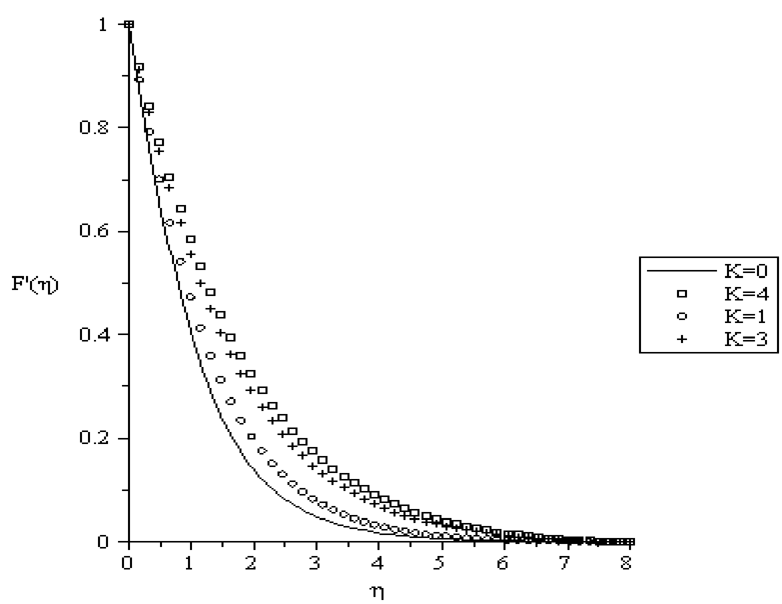

Figure 5 : Velocity profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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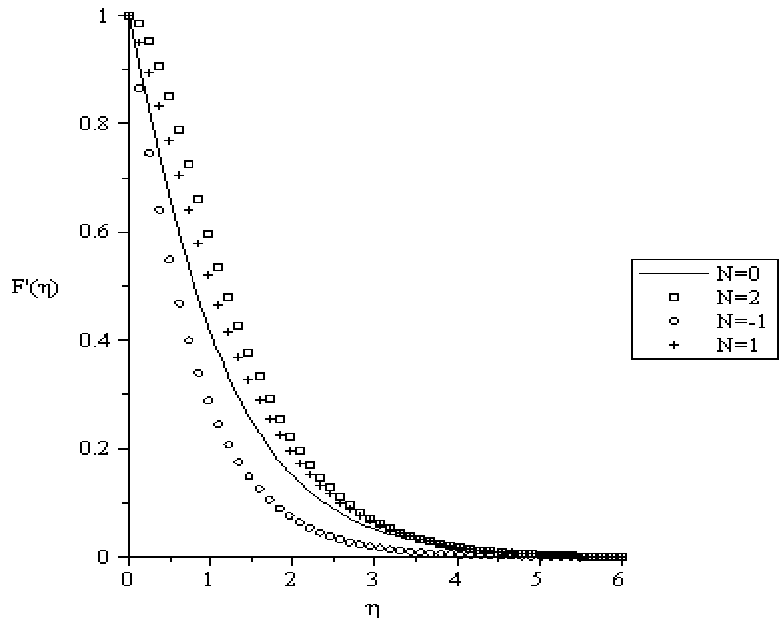

Figure 6 : Velocity profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, K=0.1

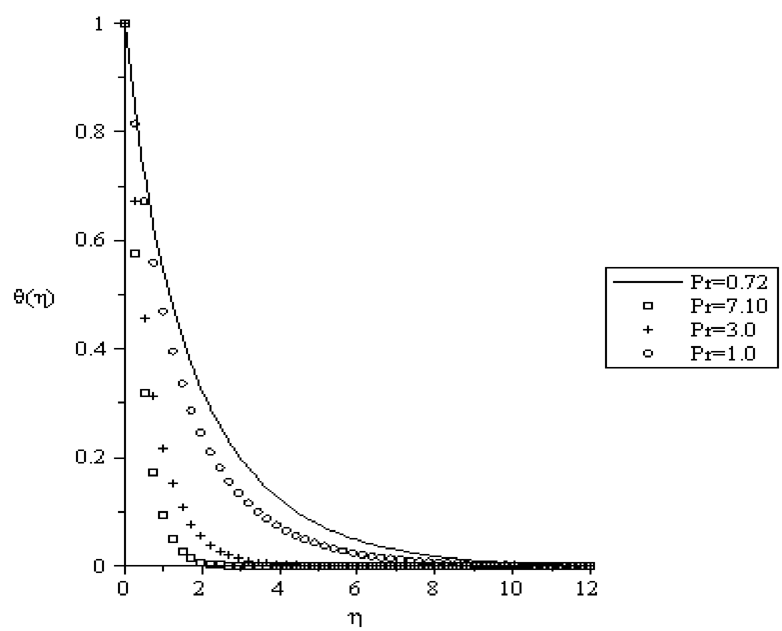

Figure 7 : Temperature profiles for γ=2, λ=1, δ=0.1, K=0.1, Du=0.1, Le=1, Sr=0.7, N=-0.5

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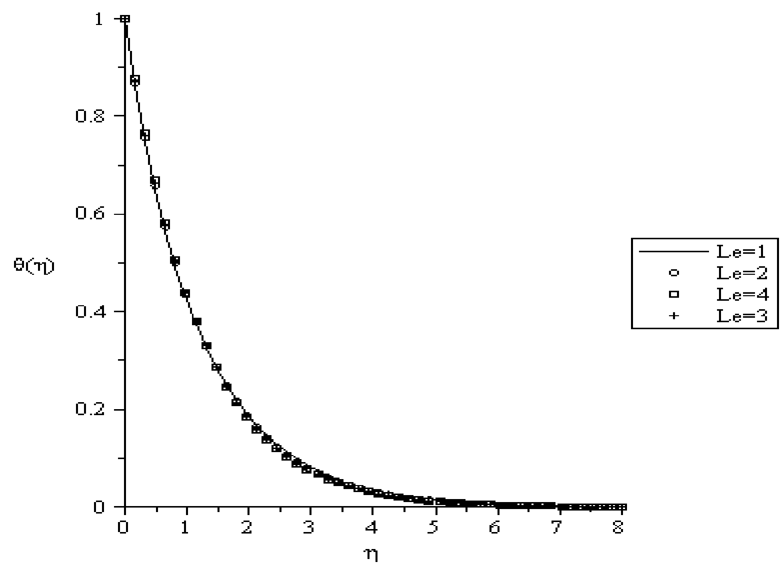

Figure 8 : Temperature profiles for $\gamma=2$, $\lambda=1$, $\delta=0.1$, K=0.1, Du=0.1, Pr=1, Sr=0.1, N=-0.1

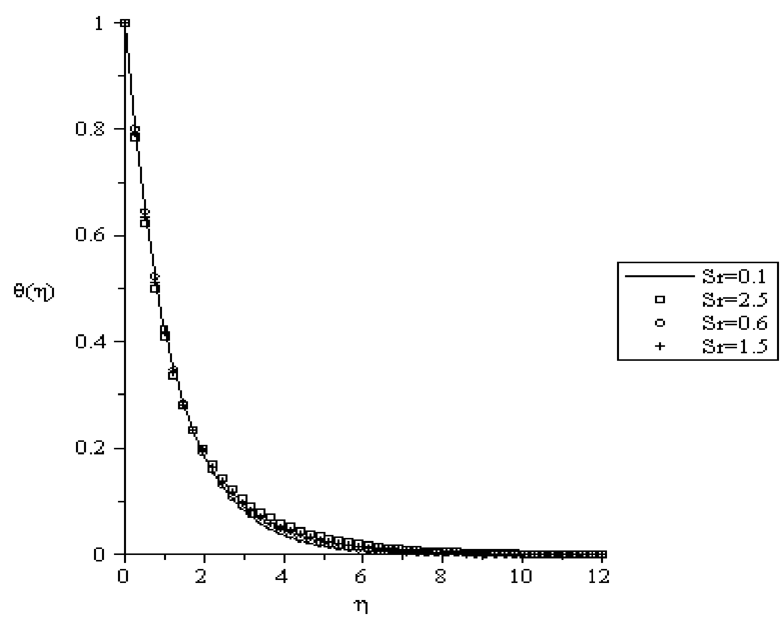

Figure 9 : Temperature profiles for $\gamma=2$, $\lambda=1$, $\delta=0.1$, K=0.1, Du=0.1, Pr=1, Le=1, N=-0.1

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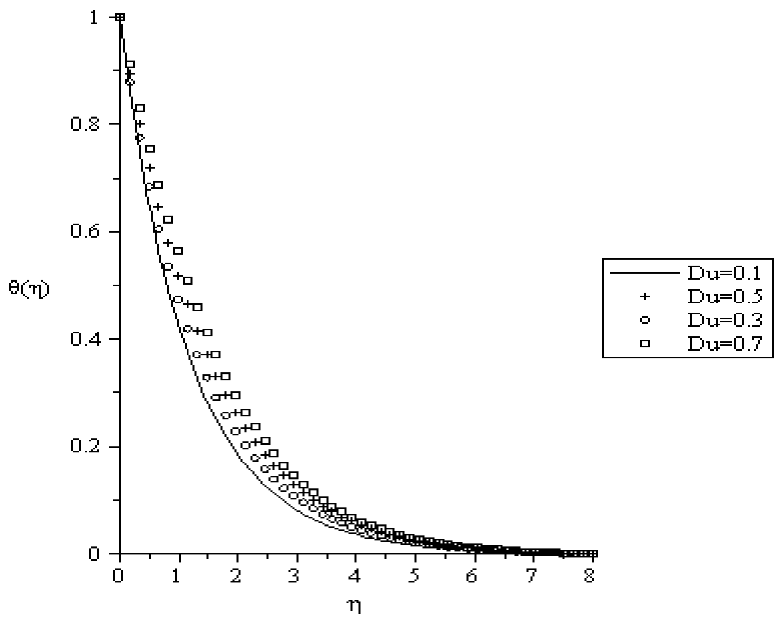

Figure 10 : Temperature profiles for γ=2, λ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

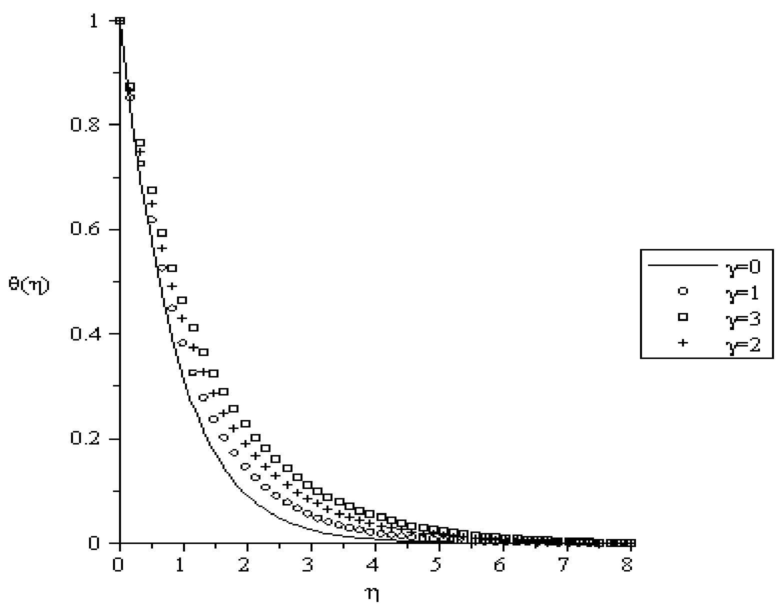

Figure 11 : Temperature profiles for Du=0.1, λ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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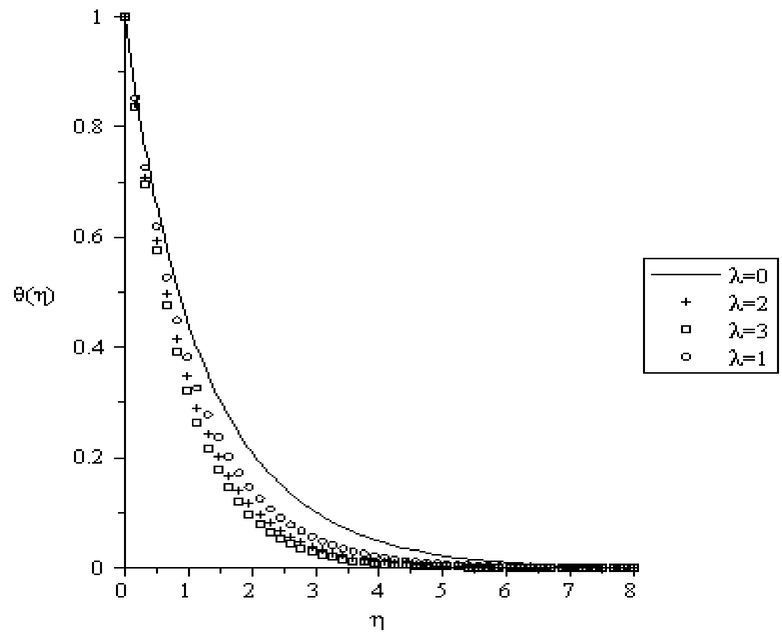

Figure 12 : Temperature profiles for Du=0.1, γ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

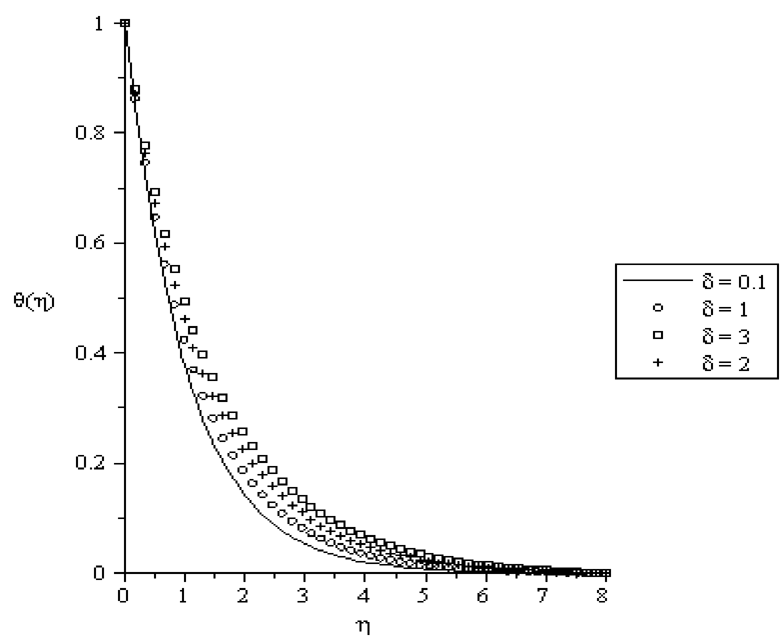

Figure 13 : Temperature profiles for Du=0.1, γ=1, λ=1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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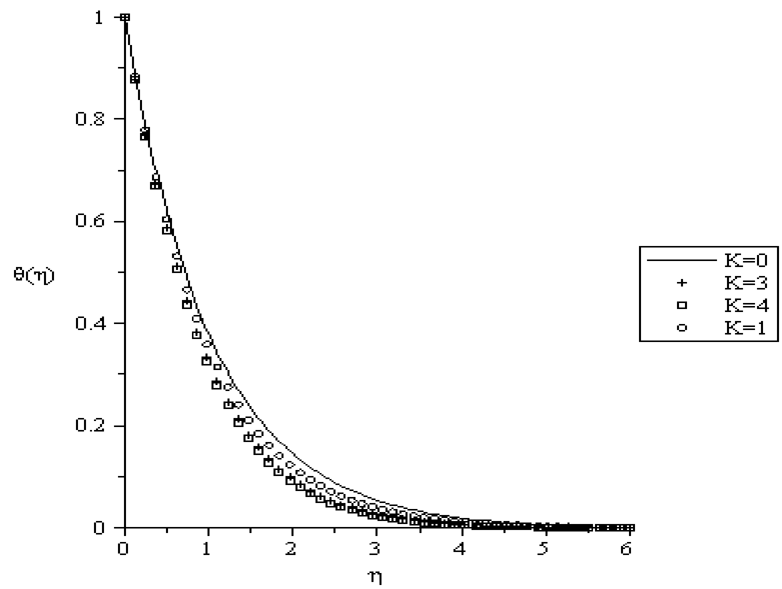

Figure 14 : Temperature profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

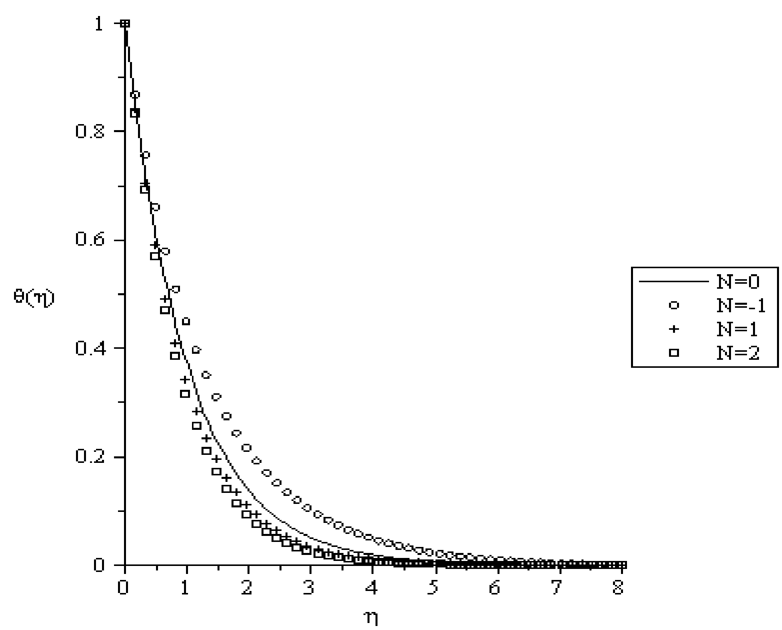

Figure 15 : Temperature profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, K=0.1

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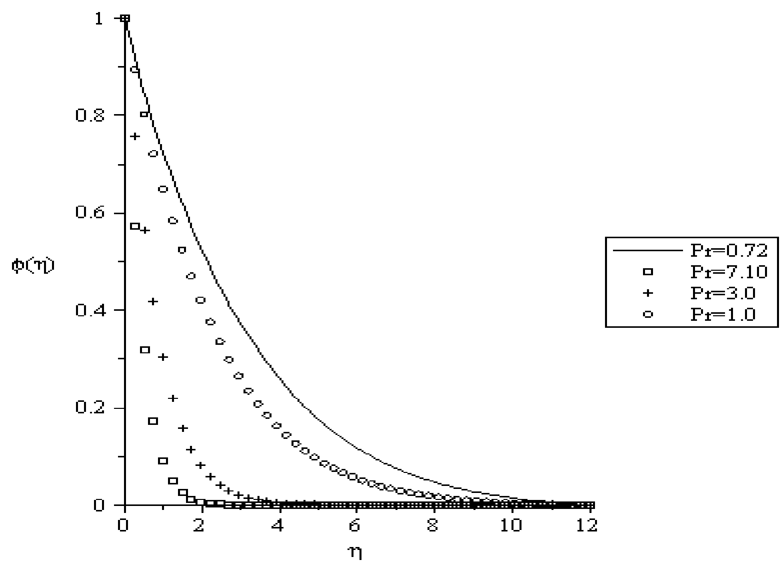

Figure 16 : Concentration profiles for $\gamma=2$, $\lambda=1$, $\delta=0.1$, $K=0.1$, $Du=0.1$, $Le=1$, $Sr=0.7$, $N=-0.5$

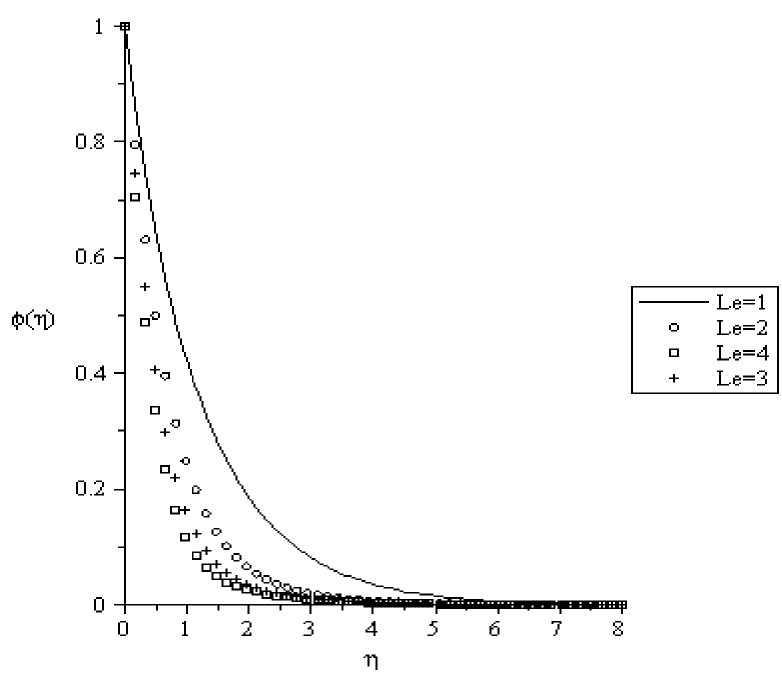

Figure 17 : Concentration profiles for $\gamma=2$, $\lambda=1$, $\delta=0.1$, $K=0.1$, $Du=0.1$, $Pr=1$, $Sr=0.1$, $N=-0.1$

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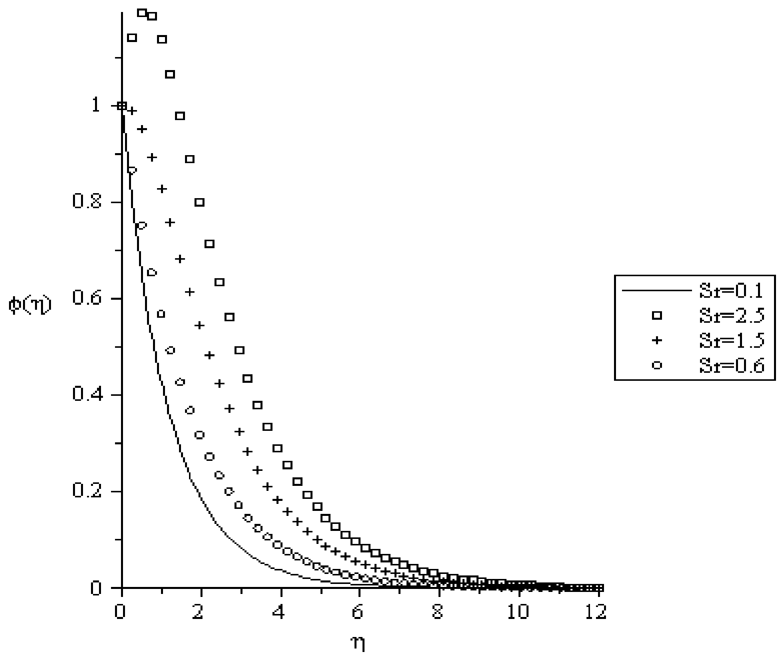

Figure 18 : Concentration profiles for γ=2, λ=1, δ=0.1, K=0.1, Du=0.1, Pr=1, Le=1, N=-0.1

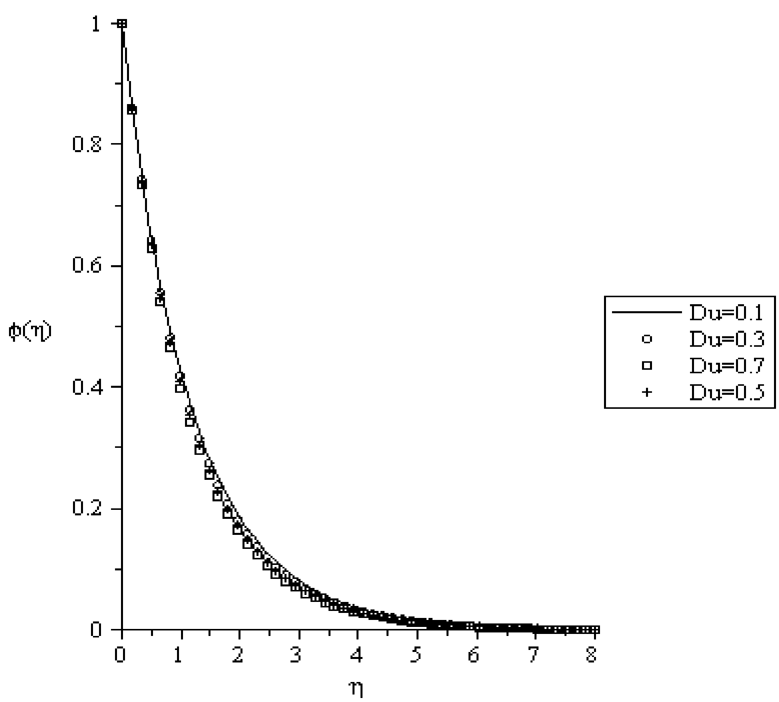

Figure 19 : Concentration profiles for γ=2, λ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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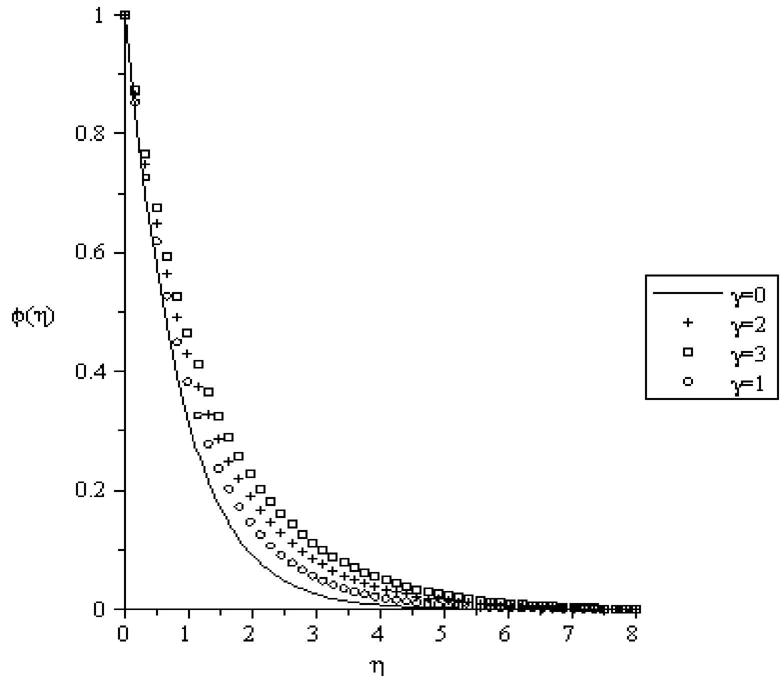

Figure 20 : Concentration profiles for Du=0.1, λ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

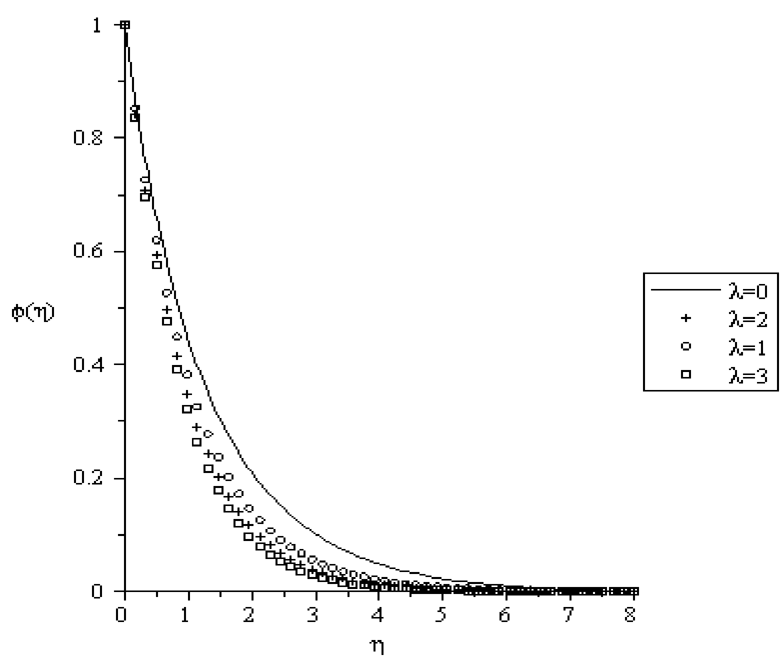

Figure 21 : Concentration profiles for Du=0.1, γ=1, δ=0.1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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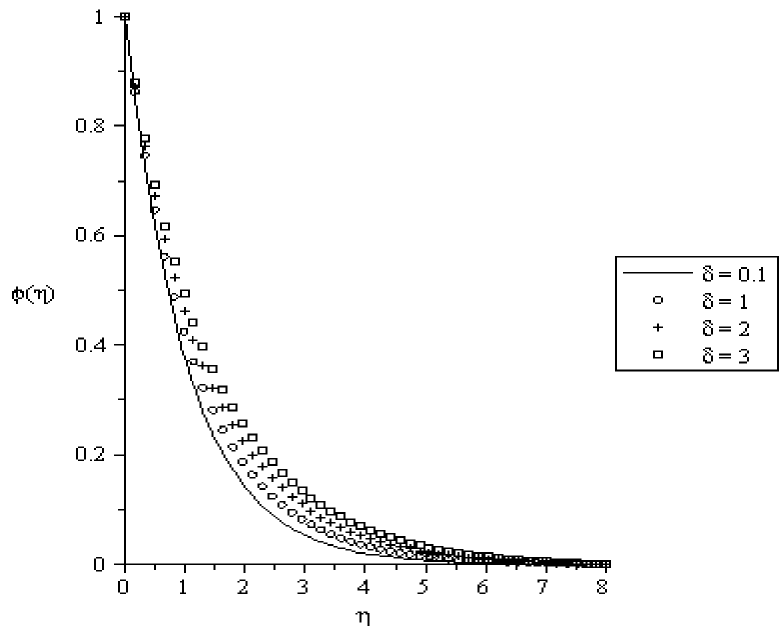

Figure 22 : Concentration profiles for Du=0.1, γ=1, λ=1, K=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

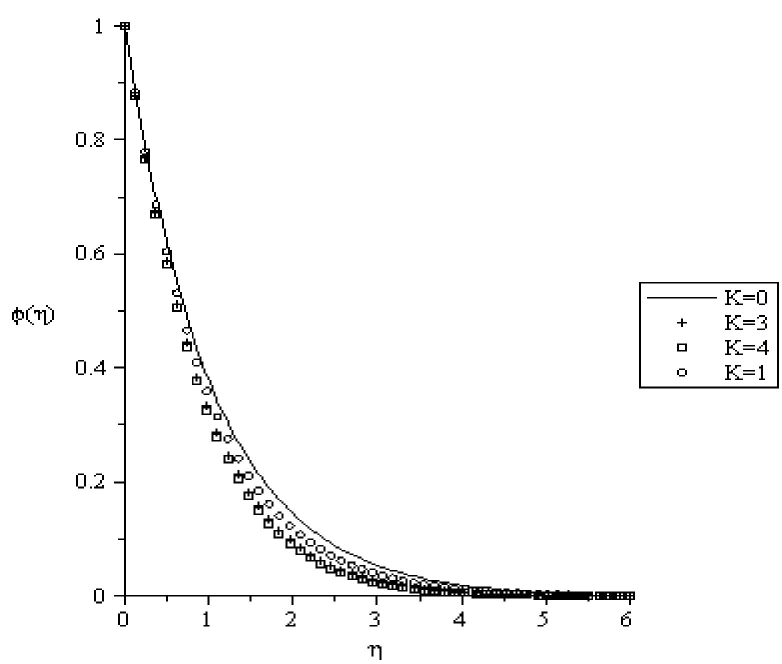

Figure 23 : Concentration profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, N=-0.1

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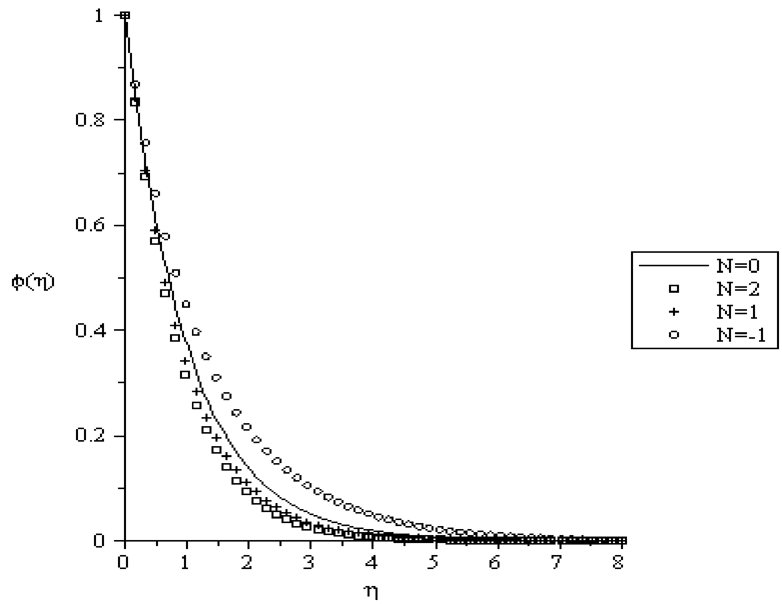

Figure 24 : Concentration profiles for Du=0.1, γ=1, λ=1, δ=0.1, Sr=0.1, Pr=1, Le=1, K=0.1

V. Conclusions

Thermal-diffusion and diffusion-thermo effects on combined heat and mass transfer on mixed convection boundary layer flow over a stretching vertical surface in a porous medium filled with a viscoelastic fluid in the presence of magnetic field is investigated. The partial differential equations governing the problem have been transformed by a similarity transformation into a system of ordinary differential equations which are solved numerically by using the shooting method with sixth-order of Runge-Kutta technique which are compared with Homotopy Adomian's Decomposition Method (HAM) for special case when magnetic field parameter is zero For fluids of medium molecular weight (H_2, air), profiles of the dimensionless velocity, temperature and concentration distributions are shown graphically for various values of parameters embedded in the flow model. Our results reveal among others that;

- the velocity boundary layer thickness decreases with an increase in dimensionless imposed magnetic field and for dimensionless mixed convection parameter we observed the following. We notice that $\lambda > 0$ corresponds to assisting flow, $\lambda < 0$ corresponds to opposing flow and $\lambda = 0$ corresponds to forced convection flow, respectively.
- the thermal boundary layer thickness increases with a decrease in K and λ and the thermal boundary layer increases as *Le, Du,* γ and δ increases.
- the local skin-friction and the rate of heat transfer at the plate increases as *Sr,* γ, δ and $N < 0$ increases and decreases as *Pr, Le, Du,* λ, *K* and $N > 0$ increases.

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(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

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Key Words

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

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- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
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Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

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Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

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Key points to remember:

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A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

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· Use present tense to report well accepted

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Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9755896

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