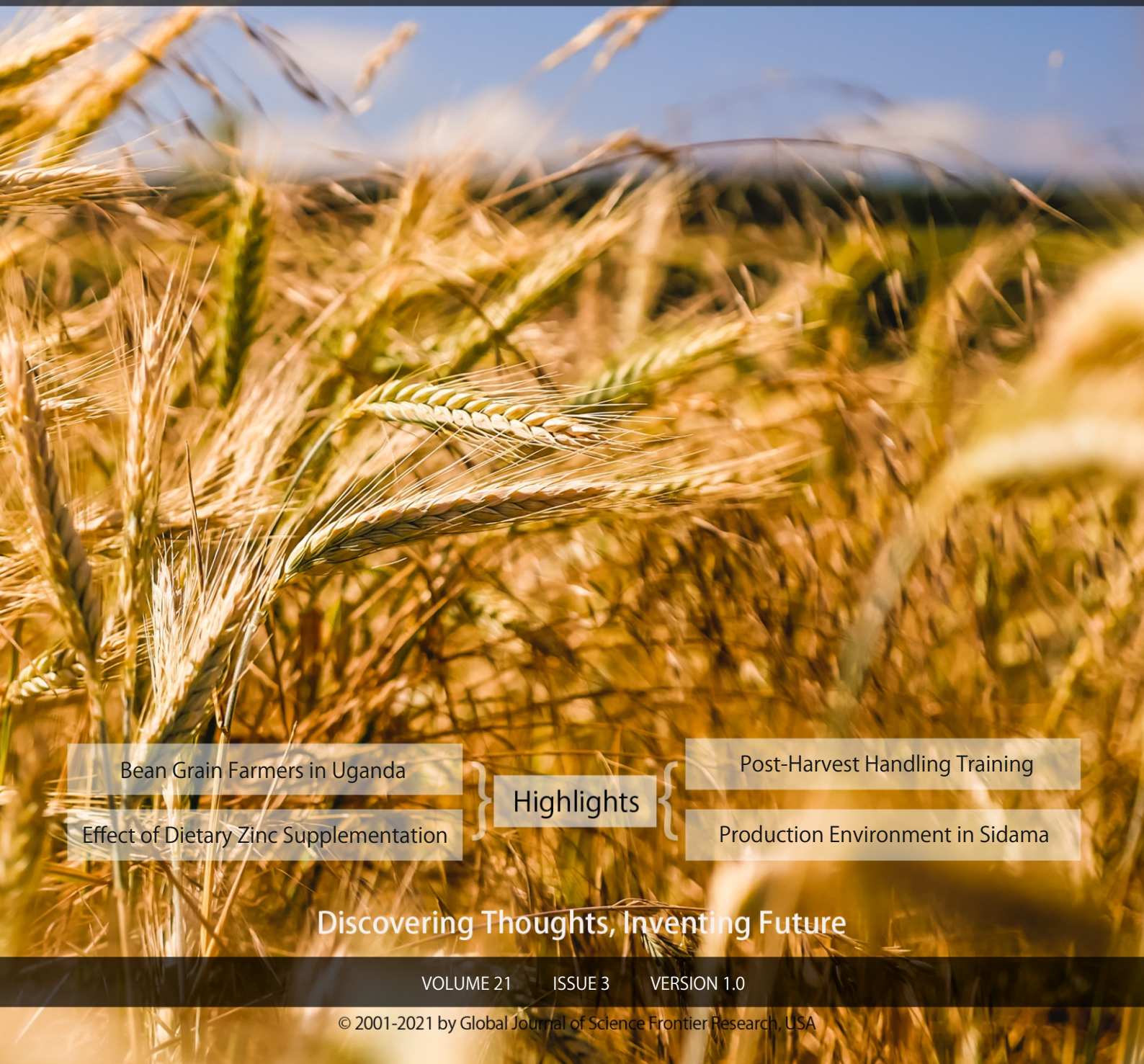
Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal

of Science Frontier Research: D

Agriculture & Veterinary



Bean Grain Farmers in Uganda

Effect of Dietary Zinc Supplementation

Highlights

Post-Harvest Handling Training

Production Environment in Sidama

Discovering Thoughts, Inventing Future

VOLUME 21 ISSUE 3 VERSION 1.0

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Volume 21 Issue 3 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*
Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals Pvt Ltd
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Excluding Air Parcel Charges):

Yearly Subscription (Personal & Institutional)
250 USD (B/W) & 350 USD (Color)

Editorial Board

Global Journal of Science Frontier Research

Contents of the Issue

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Faisabilite De La Culture Du Sorgho Pluvial En Contre Saison Dans Un Systeme D'irrigation Goutte A Goutte En Zone Soudano Sahelienne Du Cameroun

By Philippe Kosma, Yakouba Oumarou, Lando Manfouo & Kamgang Ndada Alex

Université de Maroua

Abstract- Sorghum is a strategically important commodity for food security in Cameroon and several African countries. However, the yields remain low because of several constraints among which the variability of the climatic conditions. With the aim of contributing to the improvement of sorghum production, the present study was conducted to evaluate the growth and yield performance of 03 varieties of rain-fed sorghum grown in a dry-weather system in the Sudano sahelian zone.: Maroua-Cameroon. For this purpose a completely randomized block device has been adopted. The parameters of growth, flowering and yield were recorded and analyzed. The results of the analysis show that the three varieties flowered heterogeneously.

Keywords: *sorghum bicolor, dry season, irrigation, maroua.*

GJSFR-D Classification: *FOR Code: 070199*

Strictly as per the compliance and regulations of:

Faisabilite De La Culture Du Sorgho Pluvial En Contre Saison Dans Un Systeme D'irrigation Goutte A Goutte En Zone Soudano Sahelienne Du Cameroun

Philippe Kosma [α], Yakouba Oumarou [σ], Lando Manfouo [ρ] & Kamgang Ndada Alex [ω]

Abstract- Sorghum is a strategically important commodity for food security in Cameroon and several African countries. However, the yields remain low because of several constraints among which the variability of the climatic conditions. With the aim of contributing to the improvement of sorghum production, the present study was conducted to evaluate the growth and yield performance of 03 varieties of rain-fed sorghum grown in a dry-weather system in the Sudano sahelian zone.: Maroua-Cameroon. For this purpose a completely randomized block device has been adopted. The parameters of growth, flowering and yield were recorded and analyzed. The results of the analysis show that the three varieties flowered heterogeneously. Zouaye, which started flowering very early and reaches 50% flowering at 57 JAS behaves like an early variety in front of the S 35 and CS 54 which would be late varieties in off-season. In addition, the analysis of growth parameters including stem height (P-value <0.0055x 10-16), collar diameter (P-value <3.667x 10-16) and the number of tillers (p -value <2.16), shows that there is a highly significant difference (p <0.01) for these parameters. Regarding the yield parameters for panicle length and girth characters, the CS 54 variety records the highest score (28.47 cm and 17.34 cm) while S 35 has the best 1000 grain weight. The variety with the smallest length and panicle circumference gives the lowest yield (2.86 / ha for Zouaye) while the one with higher stem height and leaf length gives the highest yield (3, 35 t / ha) which corresponds to the CS 54. An observation makes the results of analysis of the yield variables shows that the three varieties can be produced in this system drip despite the effects of the off-season. Zouaye can be recommended as forage sorghum because of its high tillering performance; CS 54 would be indicated to increase grain sorghum production in the off-season in the Sudano-sahelian zone.

Keywords: sorghum bicolor, dry season, irrigation, maroua.

Résumé- Le sorgho est une denrée d'importance stratégique pour la sécurité alimentaire au Cameroun et dans plusieurs pays d'Afrique. Cependant, les rendements demeurent faibles à causes de plusieurs contraintes parmi lesquelles les variabilités des conditions climatiques. Dans le but de contribuer à l'amélioration de la production du sorgho, la présente étude a été conduite pour évaluer les performances de croissance et de rendement de 03 variétés de sorgho pluviale cultivées dans un système goutte à goutte en contre saison en zone soudano sahélienne du Cameroun. A cet effet, un dispositif en bloc complètement randomisé a été adopté. Les paramètres de croissance, de floraison et de rendement ont été relevés et analysés. L'analyse des paramètres de croissance notamment la hauteur des tiges (P-value <0,0055x 10-16), le diamètre au collet (P-value < 3,667x 10-16) et le nombre de talle (p-value <2,16), montre qu'il existe une différence hautement significative (p<0,01) pour ces paramètres. De plus Les résultats de l'analyse montrent que les trois variétés ont fleurie de manière hétérogène. La variété Zouaye qui a débuté sa floraison très tôt et atteint les 50% de floraison à 57 JAS se comporte comme une variété précoce devant les variétés S 35 et CS 54 qui seraient des variétés tardives en contre saison. En ce qui concerne les paramètres de rendement pour les caractères longueur et circonférence de la panicule, la variété CS 54 enregistre le score le plus élevé (28,47 cm et 17,34 cm) tandis que S 35 présente le meilleur poids de 1000 grains. La variété ayant la plus faible longueur et circonférence de panicule donne le rendement le plus faible (2,86/ha pour la Zouaye) tandis que celle ayant une hauteur de tige et une longueur de feuille plus élevé donne le plus haut rendement (3,35 t/ha) qui correspond à la CS 54. Un constat fait des résultats d'analyse des variables de rendement montre que les trois variétés peuvent être produites dans ce système goutte à goutte malgré les effets de la contre saison. La variété Zouaye peut être recommandées comme sorgho fourrage vue sa performance élevée au tallage; CS 54 serait indiquée pour augmenter la production en sorgho grains en contre saison dans la zone soudano sahélienne.

Mots clés: sorghum bicolor, contre saison, irrigation, maroua.

I. Introduction

Le sorgho (Sorghum bicolor) est une plante moins exigeante en eau et en éléments minéraux par rapport aux autres céréales. C'est une plante bien adaptée aux zones semis aride peu fertiles (Nekeuam, 1983).En raison de sa capacité à résister à la sècheresse, même dans les zones où le nombre de jours de pluie est inferieur a 60 par an (Dembele, 2009), elle a de beau jour dans Sahel.

La tendance à l'amélioration de la production dans chacune des filières agricolejou s sera accentuée au Cameroun au cours des campagnes 2017 et 2018, puisque les prévisions de décembre 2016 montraient

Author α σ ρ ω: Ecole Nationale Supérieur Polytechnique de Maroua, Université de Maroua-Cameroun BP: 46 MAROUA-CAMEROUN.
e-mail: landmanfouo7@gmail.com

que grâce aux actions du Projet d'Investissement et de Développement des Marchés Agricoles (PIDMA), les rendements ont évolué (Adminon, 2017). Des améliorations des rendements sont aussi attendues dans la filière sorgho. Le PIDMA à travers ses objectifs vise à accroître la production du maïs, du sorgho et du manioc au Cameroun afin d'approvisionner les industries agro-alimentaires engagées dans les processus de réduction de leurs importations de matières premières. Ce projet agricole intéressant est une aubaine pour les agro-industries telles que Guinness Cameroun, filiale du brasseur Diageo, ou encore Nestlé Cameroun; avec lesquelles le PIDMA a déjà signé des conventions d'approvisionnement en matières premières. Selon le PIDMA, 2016 les besoins en céréales sont de: 200000 tonnes de maïs, 30000 tonnes de sorgho et 1,4 million de tonnes de racines fraîches de manioc afin de satisfaire la demande. Les besoins de Guinness Cameroun sont évalués à hauteur de 10000 tonnes par an. Or en 2016, seulement 5469 tonnes de sorgho ont été livrés (Adminon, 2017). Les producteurs de sorgho, regroupés en coopératives ont reçu la somme de 1,057 milliard FCFA dans le but d'augmenter la production nationale afin de réduire l'importation de sorgho, une matière première qui rentre dans la production de la bière (Adminon, 2017). Le gouvernement camerounais à travers ses différents centres de recherche (IRAD, CIRAD), partenaires privé (Guiness) et projet (projet C2D-sorgho) vise une amélioration de la filière afin de valoriser les méthodes de production intensive du sorgho et de ses dérivées en zone semi-aride du Cameroun. C'est dans cette même perspective que s'inscrit l'étude sur la faisabilité de la culture du sorgho pluvial en contre saison dans un système d'irrigation goutte à goutte en zone soudano sahélienne du Cameroun.

II. Problématique

Au Nord Cameroun, le contexte régional est caractérisé par des perturbations climatique et un accroissement rapide de la population qui a pour corollaire l'augmentation des besoins viviers et la diversification des besoins économiques (Mathieu 2005). Vu les effets du réchauffement climatiques sur le régime hydrique (baisse) accentué par la variabilité interannuelle et spatiale des précipitations (Somé, 1996; Bationo et Buerkert, 2001), il est très impératif de s'interroger sur les techniques de production capable d'assure une meilleure production de sorgho le long de l'année afin de satisfaire au besoin de croissant du marché national et international du sorgho. Des études menées par des chercheurs et des projets sous la tutelle de l'IRAD à l'instar du projet C2D/PAR-SORGHO et le PIDMA sur la culture du sorgho ont montré avec succès que le sorgho possède dans son patrimoine génétique des gènes de résistances lui permettant de s'adapter à des conditions climatiques défavorable à d'autres céréales comme le maïs. Cependant, malgré ses capacités d'adaptation génétiques, en culture le rendement moyen est inférieur à 1 t/ha (DGPSA/MAHRH, 2011). Dans un environnement marqué par le changement climatique, il serait donc nécessaire de mettre à la disposition des agriculteurs des variétés de sorgho performantes, tolérantes au stress hydrique et d'adopter de nouveau système de production plus efficient en eau afin de dégager une production cyclique du sorgho et par conséquent une augmentation des rendements.

III. Methodologie

a) Localisation du site d'étude

La présente étude a été menée dans la région de l'extrême nord Cameroun dans la structure Sahel Agro situé au quartier Kaliaore-Maroua, entre la société SOCODOTON et le Fond National de l'emploi (FNE). Par ailleurs, la ville de Maroua est située entre le 10°30' et 11° de latitude Nord et 14° et 14°30' de longitude Est. La ville de Maroua est également le chef-lieu département du Diamaré.

b) Matériels

i. *Matériels biologiques*

Il est constitué de trois variétés de sorgho pluvial à savoir une variété locale épurée (Zouaye) et deux variétés lignées (CS-54 et S-35) achetées à IRAD-Maroua. Ces variétés ont été choisies pour leurs qualités intrinsèques à savoir la valeur nutritionnelle et le rendement et leurs valeurs extrinsèques à savoir la demande du marché (agro-industrie).

ii. *Matériels techniques*

Pour la mise en place de l'essai, les outils suivants ont été utilisés. Il s'agit de:

- Une machette pour le nettoyage du champ;
- houe pour le labour;
- piquets pour réaliser le piquetage de la parcelle;
- double décamètre pour le dimensionnement et la mise en place du dispositif;
- ficelle Pour assurer la précision lors du dimensionnement;
- crayon à mine, stylos à bille pour la prise des données;
- balance de précision pour effectuer les pesées des grains après récolte;
- un quick de pompage électrique pour pomper l'eau du sol;
- machettes faucilles, sacs, cuvettes, bâches et étiquettes pour effectuer la récolte.

c) Méthodes

i. *Dispositif expérimental*

Le dispositif expérimental utilisé dans cette étude est un bloc de Fisher complètement randomisé avec trois traitements (Zouaye, S-35, CS-54) et trois

répétitions (blocs) comme le montre la figure 12. L'allocation des traitements aux unités expérimentales a été faite de manière aléatoire. Entre les parcelles élémentaires se trouvent les allées de 1m de largeur et entre les blocs les allées de 6m de longueur. Chaque unité Expérimentale mesure 15 m2 soit 5m x 3m et comportant 5 lignes de 10 poquets et un plant par poquet, soit 50 plants par unité expérimentale, 150 plantes par bloc et pour les 3 variétés et 450 plants au total.

ii. *Collecte des données*

Paramètres de croissance

Les caractères morphologiques mesurés sont:

- Hauteur de la tige

La hauteur des plantes a été mesurée à l'aide d'un métré ruban à 77 jours après semis et se poursuivant tous les sept jours. Sur chaque unité expérimentale, les dix plantes des poquets centraux ont fait l'objet de collète des données. A l'aide d'une barre, posé sur sol, collé sur le long de la tige jusqu'à la feuille apicale la valeur de la hauteur du plant a été d'enregistré en centimètre.

- Longueur de la feuille

Mesurée sur les mêmes plantes que la taille, elle a été prise sur la deuxième feuille après la feuille apicale. Elle a été mesure à partir de la gaine à l'extrémité de la feuille de chaque plante.

- Circonférence au collet

La circonférence au collet a été mesurée à l'aide du pied à coulisse gradué en centimètre, nous avons mesuré le diamètre de dix (10) plants par unité expérimentale. La prise des mesures concernant ce paramètre a débuté à la même période que la taille des plantes et s'est poursuivie tous les 7 jours, à l'aide d'une fiche de collecte.

- Nombre de talles

Le nombre de talle a été évalué par comptage à partir 30 JAS jusqu'à la floraison et s'effectuait tous les 7 jours sur 10 plants suivant un ordre préalablement choisi à l'aide des fiches de collecte préétablis.

Paramètres de floraison

- Date début floraison

C'est la date à laquelle la première fleur d'une plante de la parcelle est apparue (Nombre de JAS).Cela a été évalué par un comptage en circulant entre ligne de chaque parcelle et suivant les variétés.

- Date de 50% floraison

C'est la date à laquelle 50% des plantes de la parcelle ont fleuri.la prise des données a été faite tous les deux jours qui ont suivi le début de la floraison. Sur chaque parcelle le nombre de plant ayant fleurie était compté et enregistré tous les deux jours jusqu'à ce que la moitié du nombre de plant présent sur parcelle fleurisse.

- Date fin floraison

C'est la date à laquelle l'ensemble des plantes présent sur parcelle ont fleurie. Elle correspond au début de la montaison. Sur chaque parcelle le nombre de plant ayant achevé fleuraison était compté et enregistré tous les deux jours jusqu'à ce que l'ensemble des plants

Paramètres de rendement

- Longueur de la panicule

La longueur de la panicule a été mesurée après la maturité de la panicule. Elle a été prise à l'aide d'un mettre ruban sur les panicules des 10 plants préalablement choisie. C'est précisément la distance entre le nœud limitant la tige à la panicule et le dernier grain supérieur sur les mêmes plants que les autres paramétrés ont été pris.

- Circonférence de la panicule:

Sur les mêmes panicules que la longueur a été prise, la circonférence. A l'aide d'un mettre ruban la circonférence de la panicule a été mesuré.

- Poids de 1000 graines

Après un comptage manuel de 1000 graines, le poids de 1000 grains (PG) a été obtenu par pesée à l'aide de la balance électronique.

- Rendement en grain

Après récolte et battage des panicules récoltées sur chaque unité expérimentale le poids des grains a fait l'objet de mesure à l'aide d'une balance afin d'obtenir le rendement de chaque variétés.

Analyse des données

Les données collectées ont été saisies et mises en forme avec le logiciel Microsoft office Excel 2010. Ensuite elles ont été importées (séparateur: tabulation) dans le logiciel R version 3.3.1 pour analyse.

IV. Resultats et Discussion

a) Evaluation des paramètres croissance des trois variétés de sorgho testées

Le tableau 3 compare les valeurs moyennes des paramètres morphologiques des trois variétés de sorgho pluvial testées.

Tableau 1: Valeurs moyennes des paramètres morphologiques

Variétés	Paramètres morphologiques			
	Hauteur de la tige (cm)	Diamètre au collet (mm)	Nombres de talle	Longueur de la feuille (cm)
CS 54	136,57±7,54 [b]	**30,80±1,15 [b]**	1±0,49 [c]	93,61±6,78 [ab]
S 35	**137,11±3,61 [b]**	30,65±1,41 [b]	2±0,83 [b]	**96,87±4,85 [b]**
ZOUAYE	122,01±7,12 [a]	27,75±1,52 [a]	**5±1,07 [a]**	93,21±3,92 [a]

Pour chaque paramètre, les valeurs suivies d'une même lettre ne sont pas significativement différentes au seuil de 5% (ANOVA).

Les résultats de l'ANOVA montrent que les variétés CS 54 et S 35 sont identiques pour les caractères hauteur de tige et diamètre au collet. Cependant pour le caractère longueur de la feuille, on note une différence entre la S 35 et la Zouaye mais une similitude d'une part entre la CS 54 et la Zouaye et d'autre part entre la CS 54 et la S 35. Le nombre de talle diffère significativement entre toutes ces variétés et c'est la variété Zouaye qui présente plus de talles.

Le tableau présente les différents P-value comparants les variétés pour chaque paramètre mesuré. La p-value perçu entre les variétés montre qu'il existe une différence hautement significative pour l'ensemble des caractères de croissance étudiés au seuil de 5%. Cela met en évidence une plus grande diversité des caractères de croissance entre les trois variétés testées. Bien plus elle témoigne de l'hétérogénéité des variétés du point de vue phénotypique. Ces résultats corroborent celui obtenu en système pluvial à l'IRAD en 2016 qui enregistrait une différence hautement significative sur l'ensemble des paramètres de croissance pour ces mêmes variétés lors du test d'adaptabilité mené par Danbé (2016). De même, Chantereau, (1998) observe une différence significative du nombre de talle et diamètre au collet en culture de décrue sur différentes variétés de sorgho et explique cela par l'effet de la photopériode tandis Oudraogo *et al.,* (2009) qui a étudié la diversité agro-morphologique des sorghos pluvial au burkina explique cela par un effet du tallage. Kaboui(2017) signale également une différence hautement significative pour ces paramètres lors de son étude sur l'effet du tallage sur les caractéres agro morphologique de 12 accessions de de sorgho. Par contre Kouamé, (2011) en étudiant la diversité des sorghos cultivés en système pluvial en côte d'ivoire n'observe de différence significative pour le nombre de talle.

Tableau 2: Valeurs de P-value de l'effet des différents paramètres morphologiques testés

Paramètres mesurés	Source de variation		
	Effet variété	Effet bloc	Interaction Variété x bloc
Taille des plants	< 2.2e-16 ***	0.0001198 ***	0.0094012 **
Diamètre au collet	<3.677e-14 ***	0.6348	0.5253
Longueur de la feuille	<0.0005234 ***	8.830e-12 ***	2.394e-06 ***
Nombre de talles	<2e-16 ***	0.1250	0.8244

b) Poids de 1000 grains (PG)

La figure 18 présente les valeurs moyennes du poids de 1000 grains des différentes variétés de sorgho testées.

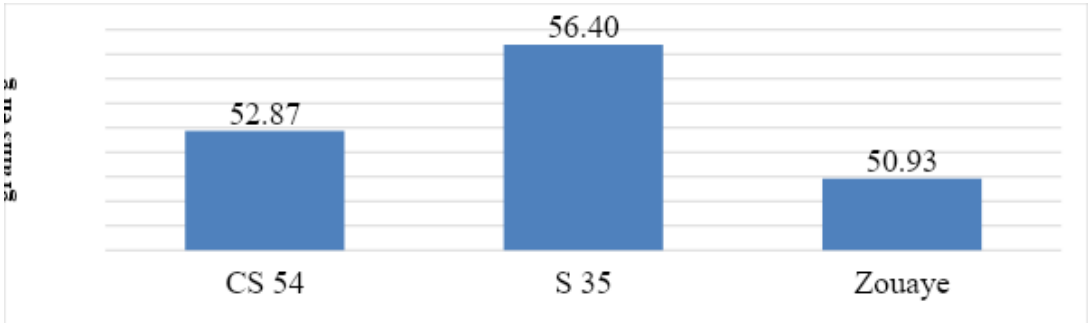


Figure 1: Variation du poids de 1000 grains

Le poids moyen de 1000 grains le plus grand est obtenu chez la variété S 35 avec une valeur de 56,40g et le poids moyen le plus petit est obtenu chez la Zouaye avec une valeur de 50,93 g qui est légèrement inférieur à celui de la CS 54 qui est de 52,87g. L'analyse de variance au seuil de 5% du poids de 1000 grains montre qu'il n'existe pas de différence significative entre ces variétés en ce qui concerne le poids de 1000 graines. Ces résultats ne concordent pas avec celui de HIEMA (2005) qui a obtenu une différence significative en étudiant les paramètres agro morphologique des sorghos de décrue en saison pluviale au Burkina en système de décrue. De même FITA (2015) dans ces travaux sur cette même variété en système pluvial obtient une différence significative pour ce paramètre.

c) Evaluation du rendement des trois variétés de sorgho testées

La figure 19 presente la valeur moyenne du rendement des différentes variétés à testées.

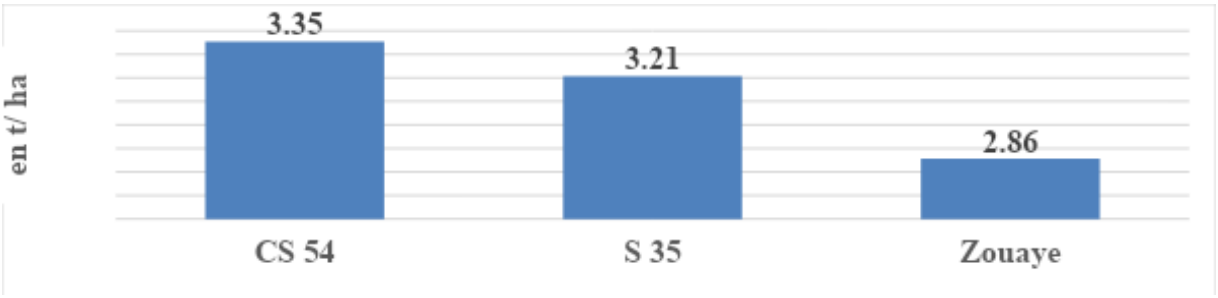


Figure 2: Variation du rendement des variétés de sorgho

La Zouaye a le plus petit rendement moyen avec une valeur de 2,86 t/ha suivie de la S 35 avec une valeur de 3,21 t/ha et de la CS 54 qui a le plus haut rendement moyen avec une valeur de 3,35 t/ha. Cependant, l'analyse de variance au seuil de 5% montre qu'il n'existe pas de différence significative entre le rendement des 3 variétés testées. Ce résultat n'est conforme à celui obtenu par Danbé (2017) qui note différence hautement significative lors de l'étude portant sur l'impact de la variabilité de la pluviométrie sur ces variétés de sorgho en système pluvial. Une différence notoire est également obtenue par Fita (2015) en évaluant les effets des cendres de neem sur les paramètres morphologiques de ces même variétés en condition pluvial qui donne un rendement de 4,5 t/ha pour la S 35,4t/ha pour la CS 54 et la Zouaye Cette variation serait due à l'effet de la contre saison sur ces variétés.

V. Conclusion

dans cette etude, il était question de**:** L'objectif poursuivi à travers cet essai était d'évaluer les comportements agro morphologiques de 3 variétés sorgho pluvial en contre saison dans un système d'irrigation goutte à goutte en zone soudano sahélienne du Cameroun afin de mettre à la disposition des producteurs et consommateurs une gamme de variétés productives et tolérantes aux différents aléas climatiques. L'analyse de variance et en composante principale nous a permis de dégager les résultats selon lesquelles les variétés de sorgho testées réagissent de manière différentes dans ce système de culture tant au niveau des paramètres de croissances tels que la taille, la longueur de la feuille, le nombre de talle et la circonférence au collet que sur les paramètres de rendement (la floraison, la circonférence et la taille de la panicule et le rendement grain). Ainsi au niveau de la floraison nous avons identifié la Zouaye comme variété précoce avec un cycle semis-50%floraison de 57 jours. De plus les résultats des paramètres de croissance (la hauteur des tiges, le diamètre des tiges, la longueur de la feuille et le nombre) ont montré des différences hautement significatives au seuil de 5% entre les variétés. Au niveau des paramètres de rendement, (Poids de 1000 grains) la S 35 a enregistré le meilleur poids (56,4 g). La CS 54 possède la plus grande longueur et circonférence de la panicule soit respectivement de 17,35 cm et 28,47 cm et par conséquent le plus haut rendement soit de 3,35 t/ha.

De cette présente étude, on peut conclure que les caractères morphologiques observés ont permis d'évaluer les performances agronomiques des différentes variétés étudiés dans la zone. La variété S 35 montre qu'elle peut être bien cultivée en saison de pluie qu'en saison sèche en zone soudano-sahélienne.

Dans le souci d'améliorer les rendements et de répondre à la demande croissante des ménages et des agro-industries, le score réalisé par la variété CS 54 et la variété S-35 montre que celles- ci peuvent être intégré dans une programme d'évaluation approfondie afin de les vulgarisés dans un programme de vulgarisation en contre saison ou en irrigation.

Bibliographies

1. Adam, L., P. Döll, C. Prigent, and F. Papa, 2010: Global-scale analysis of satellite derived time series of naturally inundated areas as a basis for floodplain modeling. Adv. *Geosci*., 27, 45-50, doi: 10.5194 /*adgeo* 27-45-2010.

2. Adminon., 2017. Agriculture- agro-industrie, Cameroun, Industrie/Manufacturing March P-28
3. AGRI-STAT, juillet 2012.: Annuaire des Statistiques du Secteur Agricole Campagnes P 56
4. Balole, T.V. & Legwaila, G.M., 2006. *Sorghum bicolor* (L.) Moench In: Brink, M. & Belay, G. (Editeurs). PROTA 1: Cereals and pulses/Céréales et légumes secs. [CD-Rom]. PROTA, Wageningen, Pays Bas P 101.
5. Barnaud A., 2007. Savoirs, pratiques et dynamique de la diversité génétique: le sorgho (*Sorghum bicolour ssp. bicolor*) chez les Dupa du Nord Cameroun. Thèse de doctorat, Université de Montpellier II, France, P 230.
6. Barrault J, Eckebil JP, Vaille T. 1972. Point des travaux de l'IRAT sur les sorghos repiqués du Nord – Cameroun. *l'agronomie Tropicale* 27(8) 791–814.
7. Bello R., 2016.Caractérisation du système de culture et optimisation de la densité de repiquage pour un meilleur rendement du sorgho (*Sorghum bicolor* (l.) moench) de contre saison a là. Mémoire de fin d'études présente et soutenu en vue de l'obtention d'un diplôme d'ingénieur agronome. ISS/ Université de Maroua P 98.
8. Bertrand M., 2005. Une démarche agronomique pour accompagner le changement technique. Cas de l'emploi du traitement herbicide dans les systèmes de culture à sorgho repique au Nord Cameroun. Agronomie. INAPG (Agro Paris Tech), Français P 47.
9. Bourema Dembélé, Manuel de formation pour la production de semences de sorgho. Mai 2011,P 36.
10. Brabant P. et Gavaud M., 1985. Les sols et les ressources en terres du Nord-Cameroun P 21
11. Bring., 2006. Evaluation des ressources en eau atmosphérique au Nord-Cameroun à l'aide des méthodes conventionnelles et satellites, Thèse de Géographie de l'Université de Ngaoundéré, Cameroun, Faculté des Arts, Lettres et Sciences Humaines, P 358
12. Burkill L.H., 1937. Les origines et la diversité des races cultivées de sorgho. *Revue de botanique appliquée et d'agriculture tropicale* 17 (191): 485_495.
13. Chantereau J. (2001): Genetics, Genomics and Breeding of Sorghum. Yi-Hong Wang,Hari D. Upadhyaya,Chittaranjan Kole, P 138
14. Chantereau J. et Nicou R., 1991. Le Sorgho. Le technicien d'agricultures tropicale. Wageningen: CTA, P 60.
15. CIRAD-CA/CALIM, 2002. Fichiers variétal, équipe ressources génétiques, TA70/01Montpellier Cedex 5, France
16. Clerget B., 2004. Le rôle du photopériodisme dans l'élaboration du rendement de trois variétés de sorgho cultivées en Afrique de l'Ouest. Thèse de doctorat, Institut National Agronomique Paris-Grignon, France, P 192.
17. Dahlberg, J. and Wasylikowa, K. 1996. Image and statistical analyses of early sorghum remains (8000 BP) from the Nabta Playa archaeological site in the Western Desert, southern Egypt. *Vegetation History and Archaeobotany* 5(4):293-299
18. Dahlberg, J., Berenji, J., Sikora, V. and Latkovic, D. 2011. Assessing sorghum [Sorghum bicolor (L) Moench] germplasm for new traits: food, fuels & uses. *Maydica* 56(2):85-92.
19. Danbé Nicodéme, 2017. Impact de la variabilité pluviométrique sur la production du sorgho pluvial dans les sous-zones agro écologique soudano sahéliennes du Cameroun,P 76.
20. De Wet et J.M.J., Harlan J.R.. et Price E.G., 1970. Origin of variability in the Spontanea complex of Sorghum bicolour. *American Journal of Botany* 57 (6): 704-707
21. Direction des études et projets agricoles, Ministère de l'agriculture.1998. Politique agricole: de nouveaux défis. Éd. DEPA.
22. Dogett H, 1988. Sorghum. 2nd ed. New York (Etats-Unis), P 30.
23. Doggett H. 1988. Sorghum. Longman Scientific and Technical, Essex, England, UK. P 512.
24. DSCN, 2002. Condition de vie des ménages et profil de pauvreté à l'Extrême-Nord Cameroun en 2001, P 19
25. F.A.O. Irrigation and Drainage paper, n° 56, FAO, Rome, 1998.
26. FAO STAT, 2010. Crops primary equivalent. Retrieved on 16th May, 2011
27. FAO, 1990. Cameroun. Mission d'identification générale de projets agricoles. FAO/DDC rapport 103/90 AF-CMR 29. Rome.
28. FAO, 1990. Gestion des eaux en irrigation: manuel de formation n0 5 sur les méthodes d'irrigation, P 39
29. FAO, 1998. Les aménagements hydro-agricoles en Afrique: situation actuelle et perspectives. Rapport sur l'eau N°5, P 333.
30. FAO, 2004. Agriculture mondiale-Horizon 2015-2030, ed. FAO, P 94.
31. FAO, 2006. AQUASTAT base de données. http://www.fao.org/ag/aquastat http://www.fao.org/docrep/005/y3618f/y3618f08.htm.
32. FAO, 2008. Manuel des techniques d'irrigation sous pression. Seconde édition, Rome, Italie; P 308.
33. Fenouillet, F. 2009. Vers une approche intégrative des théories de la motivation. In P., Carré & F., Fenouillet (Ed.), Traité de psychologie de la motivation, Paris P 45.
34. Fita Victorine, 2015.Evaluation de l'effet des cendres de neem sur paramètres agro mophologiques de trois variétés de sorgho pluviales dans la zone Soudano sahélienne du Cameroun, P 40.

35. Fokou Y O., 2015. Adaptation locale des variétés de sorgho repiqué (Sorghum bicolor) à la variabilité climatique dans la Région de l'Extrême-Nord, Cameroun. Thèse de fin d'étude, Université de Dschang,P 70.
36. Haïcha D.A., 2014. Evaluation participative de douze variétés élites de sorgho repiqué dans trois localités de l'Extrême-Nord Cameroun. Mémoire de fin de formation ISS, Université de Maroua Université de Maroua P 107
37. Harlan J.R., de Wet J.M.J., 1972. A simplified classification of cultivated sorghum. *Crop.Sci*., 12: 172-176
38. House L. R., 1987. Manuel pour la sélection du sorgho (2ème édition), ICRISAT, Patancheru, Andhra Pradesh 502324, Inde, P 70.
39. House, L. R. 1985. A guide to sorghum breeding. Second Edition. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India. P 212.
40. IBPGR/ICRISAT, 1993. Descriptors for sorghum [Sorghum bicolor (L.) Moench]. International Board for Plant Genetic Resources, Rome, Italy; International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India, P 38 .
41. ICRISAT, 2011. Résultats clés des recherches sur l'Afrique de l'Ouest et du centre. P 30
42. INS., 2015. Annuaire statistique du Cameroun Chapitre 14: Agriculture MINADER/DESA, édition 2015 P 232-255
43. IRAD, 2014: Institut de recherche agricole pour le Développement, site official (www.iradcameroun. org).Consulité en mai 2014.
44. IRAD. (2017): Institut de Recherches Agricole pour le Développement, site officiel (www.iradcameroon. org). Consulté en Avril 2017.
45. J.-P. Pierre, 1872.de taller, suff. -age*. Cf. tallement « action de taller » 1835 (Maison rustique 19et. 1, P. 224) — Lar. 20e.
46. Kaboui A, 2017. Effets du tallage aérien sur les caractères agro-morphologiques de 12 accessions de sorgho repiqué *(Sorghum bicolor* (L.)Moench) à Laf P 40
47. Kebe B. 2002. Le rôle du sorgho de décrue dans la sécurité alimentaire au Sahel, In Comas J., Gomez., (eds.). La culture du sorgho de décrue en Afrique de l'Ouest et du Centre: situation actuelle et définition d'un plan d'action régional, Madrid, AECI/FAO. P 23-30.
48. Kosma Philippe, 2018.Cours de méthodologie de la recherche et expérimentation agricole, P 36-45
49. Kouame G., Koffi C., Akanvou L., Akanvou R., Zoro Ba., Kouakou K.C. et N'DA H.A., 2011. Diversité morphologique du sorgho (*Sorghum bicolor*. moench) cultivé au nord de la côte d'ivoire. Rev. Ivoir. Sci. Technol., 17 (2011) 125 - 142 ISSN 1813-3290.P 18
50. Lobell, D. B., Hammer, G. L., Chenu, K., Zheng, B., McLean, G. and Chapman, S. C. 2015. The shifting influence of drought and heat stress for crops in Northeast Australia. Global Change Biology 21(11):4115-4127.
51. Mathieu B., 2005. Une démarche agronomique pour accompagner le changement climatique: Cas de l'emploi du traitement herbicide dans les systèmes de culture à sorgho repiqué au Nord-Cameroun. Thèse de doctorat, Institut National Agronomique Paris-Grignon, France, P 239.
52. Memento de l'agronome, 2002 4èmes éditions, P 212.
53. MINADER /DESA /AGRI STAT, (2007). Annuaire des statistiques du secteur agricole, campagne 2004 & 2005. Agri – stat n° 013.
54. Ministère de l'agriculture. 2000. Annuaire des statistiques du secteur agricole 1999/2000. Éd. DEPA Cellule des enquêtes et statistiques. P 34
55. Ministère des mines, de l'eau et de l'énergie, 2002. Etat actuel de la mobilisation des ressources en eau au Cameroun – contraintes et perspectives. éd. MINMEE-DEAU-SDAE
56. Molden, D. (2004): Irrigation Performance and Impact Assessment. Extraits du Guidelines on Irrigation and Drainage Performance Assessment: P 13.
57. Murtyd.S., Tabo R., et Ajayi o. (1995): Production et gestion des semences hybrides du sorgho. Bulletin d'information N°41, ICRISAT, P 68.
58. Nicolas N. 2007. Utilisation du sorgho en alimentation animale. Thèse de doctorat vétérinaire, Ecole Nationale Vétérinaire de Lyon P 108.
59. Olivry, 1996: Hydrologie du lac Tchad. Paris, ORSTOM. Coll Monographie hydrologique P 14
60. OMD: Rapport régional de progrès des objectifs du millénaire pour le développement région de l'Extrême-Nord, P.1-34.
61. OMM UNESCO, 2012. Glossaire International d'Hydrologie [Ouvrage]. Genève: OMM.P 469.
62. Ouedraogo M. 2014. Etude de la diversité agro-morphologique du sorgho et identification de cultivars tolérants au stress hydrique post floral. Mémoire de fin d'études En vue de l'obtention du diplôme d'Ingénieur d'Agriculture, Centre Agricole Polyvalent De Matourkou, Burkin Paris, P 543.
63. PANGIRE, 2009. Etat des lieux du secteur eau et environnement, rapport final, P 6-8.
64. Pennec F., (2009). Utilisation de la Base de données et du SIG pour l'étude de la diversité des plantes cultivées dans le Bassin du Lac Tchad. Application dans trois agro-systèmes du Nord.
65. Perrot N., Gonne S. et Mathieu B., 2002. Biodiversité et usages alimentaires des sorghos muskuwaari au Nord-Cameroun. In: Colloque Méga-Tchad, De Garine H. et al., (eds).Paris, IRD.so.73.
66. PNUD- MINEPAT, 2000: Rapport annuel d'activité.

67. Raimond C., 1999. Terres inondées et sorgho repiqué: évolution des espaces agricoles et pastoraux dans le bassin du Lac Tchad. Thèse de doctorat de Géographie, Université Paris 1,P 216
68. Ratnadass A., Djimadoumngar K. 2002. Les insectes ravageurs des sorghos repiqués ou cultivés en conditions de décrue en Afrique de l'Ouest et du Centre, In Comas J., Gomez-MacPherson H., (eds.). La culture du sorgho de décrue en Afrique de l'Ouest et du Centre: situation actuelle et définition d'un plan d'action régional, Madrid, AECI/FAO. P 65-80.
69. Raunet M., 2003.Quelques clés morphologiques pour le Nord Cameroun à l'usage des agronomes, P.1-65
70. René C., 1991. Le Sorgho. Anthologie de développement au sahel. Sahel point Doc. Editions Maisonneuve et Larose 15, rue Victor - Cousin F 75005 PARIS
71. Seignobos C., Iyébi-Mandjek O. 2000.Atlas de la province Extrême-Nord Cameroun.
72. Paris. Sine B. 2003. Evaluation d'un core collection de sorgho en conditions de déficit hydrique pré-floral. Mémoire de DEA, Université Cheick Anta Diop, Faculté des Sciences et Techniques, Dakar, P 75.
73. Shewale, S. D. and Pandit, A. B. 2011. Chapter 1: Uses of sorghum and value addition. Pages 181 in T. D. Pereira, ed. Sorghum: Cultivation, varieties and uses. Nova Science Publishers, Inc., New York.
74. Sine B. 2003. Evaluation d'un core collection de sorgho en conditions de déficit hydrique pré-floral. Mémoire de DEA, Université Cheick Anta Diop, Faculté des Sciences et Techniques, Dakar, P 75.
75. USDA, 2016. World Agricultural Production. COMMODAFRICA, Afrique - Céréales novembre 2016, P 24.
76. Vaksmann M., Traore S.B., Niangado. 1996. Le photopériodisme des sorghos africains. Agriculture et développement, 9:P 13-18.
77. Vom Brocke K., Barro-Kondombo C., Trouche G., Kambou D., Palé G., Compaoré D. 2008: Production de semences de sorgho en milieu paysan au Burkina Faso Edition: Nicole Pons. 32 P 27_
78. Wassouo Alain Felix, 2016. Cours des cultures céréalières, P 32.
79. Zolikpo A S, 2011. Caractérisation agro-morphologique des cultivars traditionnels de sorgho colorant (*Sorghum bicolor*) au Bénin. Mémoire en vue de l'obtention du Diplôme d'ingénieur agronome Université d'Abomey-Calavi (Bénin), P 66.

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

On-Farm Phenotypic Characterization of Indigenous Cattle in its Production Environment in Sidama, Ethiopia

By Debir Legesse Belay & Bereket Zeleke
South Agricultural Research Institute

Abstract- This study was conducted to phenotypically characterize the local cattle population under farmers' management conditions. Field studies and collection of data carried out through household survey, focus group discussions, and linear body measurements of sample cattle. A total of 180 households were randomly selected for household interview and 345 cattle were sampled for morphological characterization. Indigenous cattle have variable coat color types, and the most dominant were plain (56.7%), patchy (31.2%), and spotted (11.6%). The frequently observed coat color types are light red, dark red, and black. Body measurements of indigenous cattle are significantly ($P \leq 0.01$) affected by sex and location and, found to be higher in male animals and hotter environments. In male cattle between HG and BL, the linear body measurements show a strong positive correlation ($r=0.71$). Average daily milk yield, lactation yield, and lactation length were significantly ($P \leq 0.01$) higher in highlands areas. Age at first calving (53months) was also shorter in highland. The criteria used for the selection of breeding animals by the community are high milk yield, fertility, and body size. Phenotypic results of the highland cattle populations varied from the midland and lowland location and, therefore, to put specific characteristics' of the cattle type, further molecular characterization, and productivity evaluation is needed.

Keywords: *agroecology, indigenous cattle, linear body measurement.*

GJSFR-D Classification: *FOR Code: 079999*

Strictly as per the compliance and regulations of:

On-Farm Phenotypic Characterization of Indigenous Cattle in its Production Environment in Sidama, Ethiopia

Debir Legesse Belay[α] & Bereket Zeleke[σ]

Abstract- This study was conducted to phenotypically characterize the local cattle population under farmers' management conditions. Field studies and collection of data carried out through household survey, focus group discussions, and linear body measurements of sample cattle. A total of 180 households were randomly selected for household interview and 345 cattle were sampled for morphological characterization. Indigenous cattle have variable coat color types, and the most dominant were plain (56.7%), patchy (31.2%), and spotted (11.6%). The frequently observed coat color types are light red, dark red, and black. Body measurements of indigenous cattle are significantly (P≤0.01) affected by sex and location and, found to be higher in male animals and hotter environments. In male cattle between HG and BL, the linear body measurements show a strong positive correlation (r=0.71). Average daily milk yield, lactation yield, and lactation length were significantly (P ≤0.01) higher in highlands areas. Age at first calving (53months) was also shorter in highland. The criteria used for the selection of breeding animals by the community are high milk yield, fertility, and body size. Phenotypic results of the highland cattle populations varied from the midland and lowland location and, therefore, to put specific characteristics' of the cattle type, further molecular characterization, and productivity evaluation is needed.

Keywords: agroecology, indigenous cattle, linear body measurement.

I. Introduction

Ethiopia is known as a home to diverse cattle genetic resources that are adapted to and distributed in different agro-ecological zones of the country. The current livestock populations are estimated at a 59.5million, 30.7 million sheep, and 30.2 million goats. The majority of these cattle (98.2%) are local breeds that are kept undera low input system(CSA,2017).Among the livestock species, cattle have significant contributions to the livelihood of the farmers such as draught power, milk, meat, manure, cash income, social, and cultural values of the society. Indigenous livestock breeds in Ethiopia are a valuable source of genetic material because of their adaptation to harsh climatic conditions, their ability to utilize better the limited, and poor-quality feed resources, and their tolerance to a range of diseases found in these regions (Tadesse et al., 2014).Livestock contributes to about 30 percent of the agricultural gross domestic product in developing countries, with a projected increase of about 40 percent by 2030. This requires more efficient animal production systems, careful husbandry of natural resources, and measures to reduce waste, and environmental pollution (FAO, 2011).

The Domestic Animal Genetic Resources Information System (DAGRIS, 2007) database summarized 32 recognized indigenous cattle breeds in Ethiopia. Understanding the diversity, distribution, basic characteristics, comparative performance, and the current status of a country's animal genetics resources is essential for efficient, and sustainable use, development, and conservation (FAO,2007).It is difficult to design appropriate breeding programs for breeds that have not been adequately characterized either phenotypic/or genetically (Mwacharo et al., 2006).

Despite the significant contribution of livestock to the country, little attention is given to identify, characterize and conserve the diversity of the various classes of livestock (DAGRIS, 2009).The exploratory characterization approach is an important confirmatory or advanced characterization in breed identification and classification in ways that farming communities can relate(FAO, 2012).

Morphological descriptions are used to evaluate breeding goals, to assess the type, and function and to estimate the animals' value as potential breeding stock (Solomon, 20010; FAO, 2012). To ensure proper conservation and utilization of indigenous animals, it is necessary to evaluate phenotypic and genetic variation that exists within and among breeds. A large proportion of indigenous cattle in developing countries have yet to be characterized or evaluated at phenotypic and genetic levels (Hannotte, 2005). It is undertaken as a measure of genetic diversity between distinctly defined populations to understand the extent, distribution, characteristics, production and reproduction performance, utility value, and current status of the breed (Workneh et al., 2004).

Although the indigenous cattle population plays a leading role in the sustainability of livelihoods for its owners, there is no published information concerning the characteristics of this cattle type. As a result, the study was mainly focused on finding out basic

Author α σ: South Agricultural research Institute, Hawassa Agricultural research Center, Hawassa, Ethiopia. e-mail: debirlegese@gmail.com

information on the origin, ecology, physical and production characteristics, preferable traits of the indigenous cattle populations in Sidama.

II. Materials and Methods

a) Description of the study area

The study was carried out from January to June 2017 in three agroecological zones (from highland Hulla, midland Shebedino, and lowland Loka Abayaworeda) of Sidama zone. Geographically Sidama zone is situated between the coordinate of 5o 45''and 6045''N latitude and 380 39'' and 380 39''E with an altitude range of 1100 to 3500 meters above sea level. The rainfall pattern of the Sidama is a bimodal type. It has diverse agroecology classified as highlands, midlands, and semi-dry lowlands covering 30%, 60%, and 10%, respectively. The farming system is characterized as mixed crop and livestock farming and endowed with different livestock resources such as cattle, small ruminants, equines, poultry, and honeybee.

b) Sampling techniques and data collection

From each woreda, three rural kebeles which are known to keep typical and having a higher population density of indigenous cattle were purposely selected. At the same time, a random sampling technique was employed to select sample respondents. Primary data was collected using in-depth interviews and group discussions. About 180 households were randomly selected for a household interview to collect data on cattle performance, breeding practices, selection criteria, and 345 mature cattle (300 female and 45 male) sampled for morphological characterization.

c) Data analysis

Data were statistically analyzed using Software Package for Social Science (SPSS). Quantitative data were analyzed using the General Linear Model Procedure (univariate and non-parametric tests, chi square/$\chi 2$). An index method is used to calculate the overall rank. The index is the sum of (3 times first-order + 2 times second-order +1 times third-order) for individual variables divided by the sum of (3 times first-order + 2times second-order +1 times third-order) for all variables. The relationship between linear body measurement traits was estimated by simple correlation using the Pearson correlation method. The variation between groups was considered significant when the P-value was less than 0.05.

III. Results and Discussion

a) Phenotypic Description of Indigenous Cattle

Results from focus group discussions and field observations on physical features revealed that highland, midland, and lowland cattle types identified as their geographical. During the discussion, as some elders and the key informant were informed by their parents, indigenous Sidama cattle origin in the neighboring highland area of Arsi-Bale area and they were brought and reared over here by their ancestors before many years while midland and lowland cattle type they tend to associate origin with that of the ethnic group of Sidama. In all these places, indigenous cattle are used for multipurpose production functions (milk, beef, manure) and services (social value, savings). Indigenous cattle are small to medium size; both have well-developed humps, forward curved short-horned, long tail, and pigment muzzle. Earlier report Rege and Tawah (1999), indicated that cattle in Sidama is classified into Abyssinian short-horned Zebu (Ethiopian Highland Zebu) and descended from the recent introductions of zebu into Africa from West Asia, and probably developed from a group of small shorthorn Abyssinian Zebu by the highland Oromo people (DAGRIS, 2006).

The coat color patterns of indigenous cattle are variable and the most commonly observed coat color was plain (56.7%), Paid (31.2%), and spotted with different color combinations (11.6%) (Table1). The current finding of coat color pattern is somewhat comparable in Mursi cattle plain (52.0%), (paid, 36.0%), and spotted (12.0%) (Terefe et al., 2012).Cattle in midland location majority of their coat color pattern are uniform (dark red 27.8% followed by light red 24.3% and white and red paid (13.9%). The result further indicated the lowland cattle types' coat color patterns were light red (29.6%), dark red (20%), and whitish shiny (12.1%). Indigenous cattle in highland were black with white face (35.7%), black (28.7%), black and white paid (11.3%). The highland cattle coat color pattern was compatible with the result of Chali (2014) indicated that due to natural and artificial selection, black coat color type is dominating. Similarly, coat color is one of the means for cattle identification in both study locations. Similarly, coat color is used for the identification of cattle in most pastoral communities (FAO, 2009). In this regard, the study made by Tekele (2005) explained that preferred coat color patterns by the Sheko community are red, patchy red, and white. Tefere et al. (2012) also reported that multiple coat color pattern variations come from a preferential selection of the pastoral communities toward animals with variable coat color patterns and uncontrolled mating.

Table 1: Proportion of qualitative traits for indigenous cattle (N=345)

Variables	Agro-ecology			
	Highland (%)	Midland (%)	Lowland (%)	Total (%)
Hamped	100	100	100	100
Horn				
Presence	97.4	98.3	96.3	97.4
Absence	2.6	1.7	3.5	2.6
Horn orentation				
Forward curreved	69.7	65.2	67.8	67.5
Upward curved	21.7	23.5	21.7	22.3
Dawn ward	8.7	11.3	10.4	10.14
Tail				
Long	98.2	98.3	96.1	97.5
Medium	1.8	1.7	3.9	2.5
Muzile Pigment				
Pigment	100	100	100	100
Coat color patterns				
Plain	34.74	69.6	70.5	56.2
Paid	55.7	21.7	13	31.1
Spotty	9.5	8.6	16.5	11.6
Hair coat color				
Black	28.7	13	8.7	16.8
Black with white face	35.7	1.7	0.9	12.7
Black and white	11.3	6.1	3.5	7
Light red	1.7	24.3	29.6	18.6
Dark Red	2.6	27.8	20	16.1
Whitish	1.74	4.5	12.2	6
Red and white	8.7	13.9	8.6	10.4

Figure 1: Different coat colours of local cattle in highland, midland, and low land agro-ecologies

b) Quantitative Traits between Location

As a result, shown in Table 2,linear body measurements except RL and HL of indigenous cattle populations from the midland and lowland were not significantly different and has larger ($P<0.001$) measurements when compared to the highland, the variation could be due to agro-ecological different among the location, and types of the farming system. The similarity body measurements among midland and lowland study agroecology might be due to the equivalence of measurements between populations. Compared with other cattle breed characterization results, the body measurements of indigenous cattle types were superior to those of Kereyu cattle (Garoma, 2006) under the pastoral management system in Ethiopia, but still, its body frame is comparable with the highland area of Arsi cattle breed (Chali, 2014).

Table 2: Least square means of body measurements (cm) by agro-ecology (N=345)

Vaiables	Agro-ecologies			
	Hihland	Midland	Lowland	Over all
Body length	110.2±0.21[b]	113.9±0.2[a]	114.6±.2[a]	113.2±0.21
Heart girth	111.2±0.21[b]	116.9±0.2[a]	117.5±.2[a]	115.2±0.2
Ear Length	110.9±0.22[a]	111.9±0.2[a]	111.6±0.4[a]	111.5±0.21
Pelvic width	143.2±0.12[b]	151.8±0.2[a]	151.0±0.2[a]	148.7±0.11
Tail length	17.6±0.2[a]	15.5±0.2[b]	16.6±0.21[b]	16.6±0.2

Horn length	32.5±0.2 [a]	34.0±0.15 [a]	34.7±0.16 [a]	33.7±0.11
Muzzle circumstance	91.6±0.23 [a]	90.9±0.16 [a]	92.5±0.2 [a]	91.7±0.13
Hook circumstance	26.4±0.18 [a]	25.6±0.2 [a]	25.9±0.17 [a]	26.4±0.18
Cannon length	38.7±0.17 [a]	35.2±0.2 [b]	35.5±0.2 [b]	36.5±0.18
Rump length	26.4±0.18 [a]	25.6±0.2 [a]	25.9±0.17 [a]	26±0.18
Neck length	28.9±0.2 [b]	30.1±0.18 [a]	30.4±0.18 [a]	29.8±0.14
Facial profile	34.4±0.2 [b]	33.8±0.2 [b]	36.4±0.16 [a]	34.9±0.12
Neck length	35.2±0.19 [a]	35.9±0.2 [a]	35.6±0.15 [a]	35.6±0.13
Facial profile	43.1±0.15 [a]	42.9±0.2 [a]	43.0±0.18 [a]	43±0.16

Significant at[a-b] P≤0.01, HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant

c) Quantitative Traits in Female and Male Cattle

The quantitative traits of the measured cattle population in the study areas are present in Table 3. The result showed that body measurements except for HL, NL, TL, and RL all had a P≤0.05 difference among the sex of the animals. Males have the highest body measurement values for variables of BL, HW, HG, EL, TL, MC, HC, and RL. This is consistent with a report by Dessalegn (2012) and Mulugeta (2015), higher mean values of body measurements in males than females, for Arado and Begait cattle. Fasil (2014) also reported that quantitative dependent variables (BL, HG, HW, PW, MC, EL, TL, DW, HL) indigenous cattle in the Amhara region were significantly affected by the sex of the animal. Taye (2005) also reported that morphological trait measurement of indigenous male cattle is usually greater than female groups. These linear morphometric traits difference was attributable to sensual demography (Mwacharo et al., 20006).

Table 3: Linear body measurements of male and female indigenous cattle

Variable	Male (N=45)	Female (N=300)	P-value
Body length	120±9.82[a]	113.33±6.76[b]	0.0001
Height at wither	116.67±17.2[a]	110.9±0.1[b]	0.001
Heart girth	154.4±39.85[a]	141.88[b]	0.0001
Ear Length	18±0.4[a]	16.4±.01[b]	0.001
Pelvic width	31.3±0.8[b]	34.4±0.4[a]	0.001
Tail length	93.6±0.8[a]	91.5±0.3[b]	0.0001
Horn length	17.9±0.4[a]	18.9±0.1[a]	NS
Muzzle circumstance	38.5±0.4[a]	36.3±0.1[b]	0.001
Hook circumstance	29.8±0.4[a]	24.5±0.1[b]	0.0001
Cannon bone length	30.1±0.4[a]	29.8±0.1[a]	NS
Neck length	34.2±0.4[a]	34.2±0.11[a]	NS
Facial profile	43.6±0.13[a]	42.8±0.12[a]	NS
ump length	36.7±0.3[a]	34.7±0.2[b]	0.0001

*HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant, Significant at [a-b]*P≤0.01

d) Correlations

The phenotypic correlation coefficient estimates between the various traits for female and male indigenous cattle types are presented in Table 4. For females, low to moderate ₴0.001positive correlations were found among linear body measurements. HG (r=0.31), RL (r=0.312) and FL (r=0.30) showed low positive correlation with BL and HW (r= 0.42) and NL (r=0.40) had moderate positive correlation with BL. The findings on the correlation of coefficient of the current study agree with those of Chali, (2014) for Arsi female cattle. Regarding the male cattle, most of the linear body measurements are moderate, and a strong positive P≤0.001correlation was found between HG and BL (r=0.71). A similar result indicated by Andualem (2016) in males, all the linear body measurements have a positive correlation, and a strong association was found between HG. This could show the enhancement of one trait which, is a positive in correlation with other traits, that there is an opportunity to develop both traits. However, some traits of PW with TL and PW with NL were found to be weak and insignificant correlations.

Table 4: Phenotypic correlations between body measurments for female, and male cattle (N=345)

Traits	HG	BL	HW	PW	TL	NL	RL	FL
HG		0.31**	.27**	0.18*	0.10*	0.19ns	.20**	0.15*
BL	0.71**		0.42**	0.14*	0.21**	0.40**	0.312**	0.30**
HW	0.67**	0.59**		0.13*	0.15*	0.17**	0.291**	0.31**
PW	0.61**	0.57**	0.50*		0.347**	0.27**	0.388**	0.144*
TL	0.59**	0.57**	0.49*	0.17 ns		0.230**	0.153*	0.015 ns
NL	0.46*	0.61**	0.38*	0.25 ns	0.20 ns		0.292**	0.34**
RL	0.58**	0.56**	0.56**	0.58**	0.62**	0.41*		0.19*
FL	0.51*	0.56**	0.55**	0.53**	0.47*	0.47*	0.41*	

*Significant at*P<0.05, ** P<0.01 HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant*

Note: Diagonal line above for female and below for male Sidama cattle population

IV. Reproduction and Production Performance

a) Reproduction performance

The average age at first calving of the present study reported to be53±4.5. The finding, age at first calving of native cattle was longer than (39.4 months) that reported by Kumar et al. (2014) in the Tigray region. However, it was comparable with the result of Belay et al. (2012) (50.59 months) and Menale et al. (2011) (50.8 months). The average calving interval of indigenous cattle was 17.53±5.2, and there was no significant (P≥0.05) difference among the study agroecology. Reproductive lifetime productivity of male and female cattle was 7.7 ± 1.03 and 12.2 ± 1.7 years, respectively. The calving interval in the current case was shorter than reported by Shiferaw (2014)(18 months) for Kerryu cattle, but it was longer than End a shaw (2010) (14.3 months) for Mursi cattle and 15.6 months for Sheko cattle (Tekile, 2005) The longer calving interval might be due to the cows' age calving season, and forage availability of study location. The lifetime productivity of female cattle of the current result was shorter than Sheko cattle (14.7 years), as was reported by (Tekile, 2005).The findings of reproductive lifetime productivity of female cattle were in agreement 11.23 years for west Showa cattle Jiregna (2007), 11.5 years for Borana breed Dereje(2015), and 12.17 years for Arsi cattle (Chali, 2014).

Table 5: Reproduction Performance of Indignous cattle (N=180)

Variables	Agroecology			
	Highland	Midland	Lowland	Overall
Age at first calving	51.8±4.5[a]	52.0±6.5[a]	54.6±3.8[b]	53±4.5
Calving interval	17.7±4.4[a]	17.8±4.5[a]	18.1±6.2 [a]	17.53±5.2
Productive lifetime of male	8.2±1.0[a]	7.23±1.0[b]	7.1±0.8[b]	7.54±1.03
Productive life time of Female	12.8±1.7[a]	11.0 ±1.7 [b]	10.7±1.6 [b]	11.2±1.7

[a-b]different letters significant between agro-ecologies, Significant was set as p<0.01 and p<0.05,

b) Milk production performance

The mean daily milk yield, lactation length, and lactation milk yield of indigenous cattle were 1.93 liters, 221.0±55.9 days, and 429.8±61.52 liters, respectively (Table 6). The overall average daily milk yield performance of indigenous cattle in the study area was ranged from 1.62 liters in rural lowland to 2.43liters in highland area. The average daily milk yield and lactation length in highland had significantly (P<0.05) higher than those in midland and lowland study area. The average daily milk yield in the current study is slightly similar to that of Dereje (2015) reported that the on-farm daily milk yield of Wello highland zebu cattle was 1.9 liters per day. However, it was higher than the 1.37 liters national average (CSA, 2014), 1.5liters Demissu et al. (2014) for Horro cattle and 1.44 liters for Arsicattle of Ethiopia (Chali, 2014). The lactation length (LL) of the native cattle as observed in the study were shorter than those reported by Kumar(2014) (247.11±29.64 days) in Tigray, but it was longer than those reported by Gebrgziabher et al. (2013) for Boran breed (211.1±7.1), and Ngongoni et al. (2006) (201.1±21days) in Zimbabwe. The average lactation milk yield of this study was smaller than Borana (947 liters), and Horro (1201 liters) breeds Gebregziabher et al. (2013) and 645 liters for Begait breed. However, the lactation milk yield of the current result was higher than 238 liters in Yerer watershed Adalibeb woreda located in the Oromia region (Mulugeta, 2005).

Table 6: Milk yield production performance of cattle (N=180)

Variable	Agroecology			
	Highland	Midland	Lowland	Overall
Daily milk yield (liters)	2.41±0.8[a]	1.8±0.9[ab]	1.62±0.5[ab]	1.95±0.85
Lactation length (days)	245±58.3[a]	210±54.5[ab]	204.4±46.4[ab]	221.0±55.9
Lactation milk yield (liters)	589.39±87.3[a]	378.1±96.5[b]	330.3±1.0[c]	429.8±61.5

[a-c]*different letters significant between agro-ecologies, Significant was set as p<0.01 and p<0.05,*

c) Selection Criteria for Breeding Cattle

The ranking of traits for selecting breeding animals as perceived by farmers summarized in Table 7. High milk yield followed by high fertility and body size is the most highly rated trait in selecting breeding animals. Similar results indicated that cattle producers from different parts of Ethiopia select dairy cows based on milk yield (Godadaw et al., 2014. Some of the adaptive traits with disease tolerance character and coat color were mentioned as selection criteria but with a lower ranking. The adaptive traits need for the selection of their livestock, especially when the farmers have to face vagaries nature and depend on ethno veterinary medicines for treating the sick animals (Tsedeke and Edrias, 2011).

Table 7: Selection criteria for breeding of cattle in the study area (N=180)

Parameter	Agroecology											
	Highland				Midland				Lowland			
	1st	2nd	3rd	index	1st	2nd	3rd	index	1st	2nd	3rd	index
High milk yield	73.3	23.3	0	0.31	71.7	11.7	15	0.30	78.8	21.2	0	0.29
High fertility	21.7	58.3	18.3	0.27	16.7	81.6	0	0.27	13.5	59.6	26.9	0.26
Body size	0	16.7	76.7	0.2	11.7	5	68.3	0.21	7.7	9.6	42.3	0.15
Feeding behavior	5	0	1.7	0.1	0	0	3.3	0.1	0	9.6	23.1	0.1
Good temperament	0	0	1.7	0.04	0	3.3	13.3	0.04	0	0	7.7	0.03
Coat color	0	1.7	1.7	0.05	0	0	0	0.02	0	0	0	0.09
Disease resistance	0	0	0	0.03	0	0	0	0.06	0	0	0	0.08

Index=the sum of (3 times first order + 2 times second order + 1 times third order) for individual variables divided by the sum of (3 times first order + 2 times second order + 1 times third order)

V. Conclusion and Recomandation

Indigenous cattle in each study location dominant with forward and upward curved horn shape orientation and hamped. Animals in the study areas have variable coat color types, and the most dominant coat color patterns were plain, patchy, and spotted. This variability shows the absence of selection towards particular traits and may have contributed to their production environment. Sex of animals had a significant effect on linear body measurement traits, and males had higher linear body measurements than their female counterparts. Most of the linear body measurements of the male animals are moderate, and a strong positive correlation was found between HG and BL. Indigenous cattle play multi-functional roles and mostly kept milk for home consumption and income source. Owners preferred high milk yield, fertility, and body size traits. Natural uncontrolled mating is the most common system of mating due to the free grazing system practice of the area. More specifically, the cattle in Sidama area are similar to the Arsi-Bale breed in their body measurement traits. The productivity performance of indigenous cattle is comparable to some other zebu cattle in the country such as low milk yield performance, long age at first calving, long calving interval, and short reproductive lifespan. Phenotypic result of highland sample cattle populations varied from midland and lowland areas and therefore; to put specific characteristics' of the cattle type, further molecular characterization, and productivity evaluation is needed to fully describe the cattle type.

Acknowledgment

This study was conducted by the South Agricultural Research Institute (SARI), Hawassa Agricultural Research Center. The authors fully acknowledged, and give appreciation for the financial support of SARI and the research participants, mainly cattle owners. Finally, the integration and cooperation

offered by Livestock and Fishery Development Offices of the respective woreda are also acknowledged for their unreserved support and full involvement during the data collection.

References Références Referencias

1. Andualem Tenagne, Getinet Mekuriaw & Dillip Kumar. 2016. Phenotypic Characterization of Indigenous Cattle Populations in West Gojjam Administrative Zones, Amhara National Regional State, Ethiopia. *J. Life Sci. Biomed.* 6(6): 127-138, ISSN 2251-9939.
2. Ayantu M, Haile A., Dessie T. and Mekasha Y. 2012. On farm characterization of Horro cattle breed production systems in western Oromia, Ethiopia. Livestock Research for Development. 24(100). http.//www.lrrd.org/lrrd24/6/meko24100.htm
3. Azage T., Gebremedhin, B., Hoekstra, D., Belay, B. and Mekasha, Y. 2013. Smallholder dairy production and marketing systems in Ethiopia. IPMS experiences and opportunities for market-oriented development.
4. Belay D., Yisehak K. & Janssens G. P J. 2012. Productive and Reproductive Performance of Zebu X Holstein-Friesian Crossbred Dairy Cows in Jimma Town, Oromia, Ethiopia. Global Vet. 8. 67-72.
5. Chali Y. 2014. Phenotypic Characterization and Production System Study of Arsi Cattle type in Arsi highland of Oromia Region, Ethiopia. M.Sc. Thesis, Haramaya University, Haramaya, Ethiopia.
6. CSA (Central Statistical Agency). 2014. Agricultural sample survey 2013/14, Report on Livestock and Livestock characteristics. Volume II, Addis Ababa, Ethiopia.
7. CSA. 2015 Agricultural sample survey (2014/2015). Report on land utilization (private peasant holdings, Meher season). Statistical Bulletin 578 (Vol. IV, Addis Ababa, Ethiopia.
8. CSA. 2017. Agricultural sample survey (2016/.2017), Report on Livestock and Livestock characteristics. Statistical Bulletin 585 (Vol. II), Addis Ababa, Ethiopia.
9. DAGRIS (Domestic Animals Genetic Resources Information System). 2007. Domestic Animals Genetic Resources Information System (DAGRIS). (eds). S.Kemp, Y. Mamo, B. Asrat and T.Dessie). International Livestock Research Institute. Addis Ababa.
10. DAGRIS (Domestic Animals Genetic Resources Information System). 2009. Domestic Animal Genetic Resources Information System. http:// dagris.ilri.cgiar.org/display.asp
11. Demissu H., Fekadu, B. &Gemeda D. 2014. Dairy Productive Potential, Challenges and Production opportunities of Horro and their F1 Jersey Crossbred Cows. A Case of Guduru Livestock production and Research Center and Its Surroundings, West Oromia, Ethiopia. Science, Technology and Arts Research Journal.3 (4).79-84.
12. Dereje B. 2015. On Farm Phenotypic Characterization of Indigenous Cattle and Their Production Systems in BakoTibe and Gobusayo Woredas of Oromia Region, Ethiopia. An M.Sc. Thesis. Haramaya University, Haramaya, Ethiopia.
13. Dessalegn G, Mekonnen H, Kelay B. 2012. Morphometric characteristics and livestock keeper perceptions of Arrado cattle breed in northern Tigray Ethiopia Livestock Research for Rural Development vol24 http:/ /www.cipav.org.co/lrrd.
14. Endashaw Terefe. 2010. Characterization of Mursi Cattle Breed in its Production Environment in Salmagado Woreda, South West Ethiopia. M.Sc. Thesis. Haremaya University College of agriculture, Ethiopia.
15. EndeshawAssefa. 2007. Assessment on production system and marketing of goats at Dale district (Sidama Zone. MSc thesis of Hawassa University, Hawassa Ethiopia. http://dagris.ilri.cgiar.org.
16. FAO, 2005 (Food and Agricultural Organization).Measurmnets of domestic animal diversity: Recommended microsatellite markers. htt://dad.fao.org/cgi-bin/getblob.cgi.
17. FAO. 2007. Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration. Rome available at http://www.fao.org/docrep/010/a1404 e/a1404e00.htm).
18. FAO (Food and Agricultural Organization). 2011. Molecular genetic characterization of animal genetic resources. *FAO Animal Production and Health Guidelines*. No. 9. Rome (available at http: //www. fao.org/docrep/014/ i2413e/i2413e00.htm).
19. FAO (Food and Agricultural Organization). 2012. Phenotypic characterization of Animal Genetic resources. FAO Animal Production and Health Guidelines No. 11. Rome.
20. FAO. 2009. Contributions of Smallholder Farmers and Pastoralists to the development and Conservation of Animal Genetic Resources. Intergovernmental technical working group on Animal Genetic Resources for Food and Agriculture.5thSession, Rome, 28-30 January 2009.
21. GaromaSh, 2006. In-situ Phenotypic Characterization of Kereyu cattle type in Fentale district of Oromia Region, Ethiopia. M.Sc. Thesis. School of Graduate Studies. Haramaya University.
22. Gebregziabher, G., Skorn, K., Mauricio, A. Elzo and Thanathip, S. 2013. Variance Components and Genetic Parameters for Milk Production and Lactation Pattern in Ethiopian Multibreed Dairy Cattle Population. *Asian Australas. J. Anim. Sci.* 26 (9): 1237-1246.
23. Godadaw M., Zewdu W. and Workneh A. 2014. Breeding practices in indigenous dairy cattle

breeds in Northern Amhara, Ethiopia. Livestock Research for Rural Development.*26 (62).* http://www.lrrd.org/lrrd26/4/misg 26062.htm.

24. Hannotte O. and Jianlin H. 2005. Genetic characterization of livestock populations and its use in conservation decision making. In: Ruane, J. and A. Sannino, eds. Pp. 89-96.The role of biotechnology in exploring and protecting genetic resources, Rome.
25. Jiregna Dessalegn. 2007. Characterization of cattle genetic resources in their production system context in Dannoworeda, west Showa, Oromia, Ethiopia. An M. Sc Thesis presented to the School of Graduate Studies of Haramaya University, Haramaya, Ethiopia.
26. KelayBelihu, 2002. Analysis of dairy cattle breeding practices in the selected area of Ethiopia. PhD dissertation, Humboldt University, Berlin. 35-45pp.
27. Kumar N., Yemane A., Berihu G. and Yohannes H. 2014. Productive and Reproductive Performance of Local Cows under Farmer's Management in and around Mekelle, Ethiopia's Journal of Agriculture and Veterinary Science, Volume 7, Issue 5 Ver. III. PP 21-24.
28. Menale M., Mekuriaw G. and Taye M. 2011. Reproductive Performance of Begait Cattle at Metekel Cattle Breeding and Multiplication Ranch, North West Ethiopia. Journal of Animal and Feed Research, 1(3): 99-106.
29. Mulugeta Ftiwi and Berhan Tamir. 2015. Phenotypic characterization of indigenous cattle in Western Tigray, Northern Ethiopia. Indian J. Dairy Sci. 68(2), 2015.
30. Mulugeta, A. 2005. Characterization of dairy production systems of Yerer watershed Adalibeb woreda, Oromia region, Ethiopia. MSc Thesis. Dire-Dawa, Ethiopia.
31. Mwacharo, J.M., Okeyo, A.M., Kamande, G.K. & Rege, J.E.O. 2006. The small East African shorthorn zebu cows in Kenya. I: Linear body measurements. Tropical Animal Health and Production 38, 65-74.
32. Ngongoni N. T., Mapiye C., Mwale M. &Mupeta B. 2006. Factors affecting milk production in the smallholder dairy sector of Zimbabwe. Livestock Research for Rural development 18 (72). http.//www.lrrd.org/lrrd18/5/ngon18072.htm
33. Rege, J.E.O., Ayalew, W., Getahun, E., Hanotte, O. andDessie, T. (eds). 2006. DAGRIS (Domestic Animal Genetic Resources Information System). International Livestock Research Institute, Addis Ababa, Ethiopia. http://dagris.ilri.cgiar.org.
34. Rege, J.E.O., Tawah, C.L.1999. The state of African Cattle genetic resources of Geographical distribution characterization and use of present-day breeds and strains. Animal Genetic Resource Inform 25:1-25.
35. Shiferw, G., 2007. In situ Phenotypic Characterization of Kereyu cattle type in Fentale district of Oromia Regional State, Ethiopia. Msc. Thesis. Haremaya University college of Agriculture, Ethiopia. 60-65pp.'
36. Shiferaw G. 2014. In-situ phenotypic characterization of Kereyu cattle type in Fentalleworeda of Oromia Region, Ethiopia, M.Sc. Thesis in Animal genetics and breeding, Haramaya University.
37. Solomon Abegaz, J. Sölkner1, S. Gizaw3, T. Dessie4, A. Haile5 and M. Wurzinger. 2013. Western lowland goat breeds in Ethiopia: implication for community-based breeding programmes: Animal Genetic Resource. ISSN: 2078-6336.
38. Solomon, T. 2010. On-Farm Phenotypic Characterization of Boran Cattle Breed in Dire Woreda of Borana Zone, Oromia Region, Ethiopia. MSc. Thesis, Haramaya University.
39. Tadesse A, Zeleke M and Berhanu B. 2014.Status and constraints evaluation of artificial insemination in cattle in the three selected woredas of Western Gojjam Zone; Amhara Region, Ethiopia. African Journal of animal production and Husbandry 1(2): 20-28.
40. Takele T. 2005. On-Farm Phenotypic Characterization of Sheko Breed and Their Habitat in Bench Maji zone, Ethiopia. An M.Sc. Thesis, Haramaya University, Haramaya, Ethiopia.
41. Taye T. 2005. On-Farm Phenotypic Characterization of Sheko Breed of Cattle and Their Habitat in Bench Maji zone, Ethiopia. MSc Thesis. Alemaya University, Ethiopia.
42. Terefe, E., Dessie, T., Haile, A., Mulatu, W. &Mwai, O. 2012. Husbandry and breeding practices of cattle in Mursi and Bodi pastoral communities in Southwest Ethiopia. Afr. J. Agric. Res., 7(45): 5986–5994.
43. Tsedekekocho and EndriasGeta. 2011. Agro-ecologic mapping of livestock system in smallholder crop-livestock mixed farming of Wolita and Dawuro districts, Southern Ethiopia.
44. Workneh A., Getahun., Markos T, Yetnayet M and J.E.O. Rege. 2004. Current State of Knowledge on Characterization of Farm Animal Genetic Resources in Ethiopia. In: Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 28-30, 2003.

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Effect of Dietary Zinc Supplementation on the Productive Performances, Carcass Traits and Blood Profile of Broiler

By Md. Firojul Islam, Md. Ahsan Habib, Ummay Salma & Sabuj Kanti Nath
Hajee Mohammad Danesh Science and Technology University

Abstract- This study was conducted to determine the effect of zinc on the productive performances, carcass yield and blood profiles of broilers. Experiment was done for a period of 35 days with a number of 60 day old broiler chicks. Birds were divided into four dietary treatment groups with 3 replications each having 5 birds per replication. The dietary treatment groups were; T_0 (basal diet; no zinc), T_1 (basal diet + 50 mg zinc/kg feed), T_2 (basal diet + 100 mg zinc/kg feed), T_3 (basal diet + 150 mg zinc/kg feed). Results indicated that body weight and body weight gain were increased significantly ($P<0.05$) in the zinc supplemented group compared to the control group. Higher ($P<0.05$) feed intake and better ($P<0.05$) FE were also observed in the zinc supplemented group than control group and best performance was observed in the group fed 150mg zinc/kg feed (T_3). Carcass yield was significantly higher ($P<0.05$) in the groups fed dietary zinc. Net profit was slightly higher in the T_3 group but not significantly (P.0.05) differed with the control group. However, T_1 and T_2 showed less profit even than the control group. Blood profile of the experimental birds including Hb, PCV and ESR did not significantly differed ($P>0.05$) among the groups. The results indicate that addition of zinc in the broiler diet improves productive performances, carcass yield and increases net profit without affecting health status of broiler. So, zinc can be used as an effective and useful micronutrient to improve the performances of broiler.

Keywords: *zinc, productive performances, carcass yield, blood profile, net profit and broiler.*

GJSFR-D Classification: *FOR Code: 079999*

Strictly as per the compliance and regulations of:

Effect of Dietary Zinc Supplementation on the Productive Performances, Carcass Traits and Blood Profile of Broiler

Md. Firojul Islam [α], Md. Ahsan Habib [σ], Ummay Salma [ρ] & Sabuj Kanti Nath [ω]

Abstract- This study was conducted to determine the effect of zinc on the productive performances, carcass yield and blood profiles of broilers. Experiment was done for a period of 35 days with a number of 60 day old broiler chicks. Birds were divided into four dietary treatment groups with 3 replications each having 5 birds per replication. The dietary treatment groups were; T_0 (basal diet; no zinc), T_1 (basal diet + 50 mg zinc/kg feed), T_2 (basal diet + 100 mg zinc/kg feed), T_3 (basal diet + 150 mg zinc/kg feed). Results indicated that body weight and body weight gain were increased significantly ($P<0.05$) in the zinc supplemented group compared to the control group. Higher ($P<0.05$) feed intake and better ($P<0.05$) FE were also observed in the zinc supplemented group than control group and best performance was observed in the group fed 150mg zinc/kg feed (T_3). Carcass yield was significantly higher ($P<0.05$) in the groups fed dietary zinc. Net profit was slightly higher in the T_3 group but not significantly (P.0.05) differed with the control group. However, T_1 and T_2 showed less profit even than the control group. Blood profile of the experimental birds including Hb, PCV and ESR did not significantly differed ($P>0.05$) among the groups. The results indicate that addition of zinc in the broiler diet improves productive performances, carcass yield and increases net profit without affecting health status of broiler. So, zinc can be used as an effective and useful micronutrient to improve the performances of broiler.

Keywords: zinc, productive performances, carcass yield, blood profile, net profit and broiler.

I. Introduction

Poultry sector is one of the most emerging and feasible sector for Bangladesh. Poultry industry can contribute to the GDP growth rate by managing food security as well as ensuring employment and reducing poverty at a large scale. Large proportion of daily human intake of animal protein comes from livestock products. Poultry industry provides quality protein to the people of Bangladesh at the lowest price. Poultry meat especially chicken meat is the most desirable animal protein and is acceptable to most of the people belonging to all castes and religions. Per capita requirement for meat in Bangladesh is 120 g meat/day but per capita consumption is only 16.5 day with a deficiency of 50.15% (Amin, 2015). The availability is quite inadequate for normal growth and development of the body. Whereas, world per capita consumption of poultry meat is 30.14 g /day, which is 95.89 g/day for USA (Farrell et al., 2003). Per capita meat consumption in Bangladesh was 5.1, 5.2 and 5.3 kg for the years 2008-2009, 2010-2011 and 2011-2012 respectively (BBS, 2012).

Broiler is one of the most important poultry used for fulfilling the protein demand. The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a chick attains maximum marketable weight. Broiler raisers are always interested to different approaches for attaining better growth and economic production. Unfortunately, farmers are using antibiotics with broiler feed to improve growth and feed efficiency, which adversely affects on human health. Antibiotics used as growth promoters tend to be given in feed at sub-therapeutic levels over extended periods to entire herds and flocks. Until recently, the major concerns about incorporation of antibiotics in animal feeds related to antibiotic residues in products from treated animals. Now there is mounting evidence that the antibiotics are widely used on farm animals are also diminishing the power of important antibiotics to help people. As a result, each and every chicken is becoming a depot of antibiotics and other inorganic substances. When these chickens are consumed by human these antibiotic and other inorganic residue enters into human body and causes serious human health hazards with drug resistance (Kibria *et al.,* 2009). For this reason European Union has banned regulation the use of antibiotics in animal production from 2006 and its use has become limited in other developed countries. Due to the ban of antibiotic growth promoters in poultry diets in different countries, it is of high interest to investigate potential alternatives to maintain good growth performance of broilers.

Zinc (Zn) is the essential trace element for growth, enzyme structure and function, appetite, normal immune function, maintenance and with particular

Author α: MS, Department of General Animal Science and Nutrition, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
Author σ: Lecturer, Department of Livestock Production and Management, Khulna Agricultural University, Khulna, Bangladesh. e-mail: ahhelal313@gmail.com
Author ρ: Professor, Department of General Animal Science and Nutrition, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
Author ω: Lecturer, Department of Animal Nutrition, Khulna Agricultural University, Khulna, Bangladesh. e-mail: sabuj.vet@gmail.com

importance for fast-growing of poultry. Trace mineral, such as Zn is essential for broiler growth and are involved in many digestive, physiological, and biosynthetic processes within the body .It function primarily as catalysts in enzyme systems within cells or as parts of enzymes. It is the also constituents of hundreds of proteins involved in intermediary metabolism, hormone secretion pathways, and immune defense systems (Dozier *et al.*, 2003). Traditionally, these trace minerals are supplemented in the form of inorganic salts; such as sulfates, oxides, and carbonates, to provide levels of minerals that prevent clinical deficiencies, allow the bird to reach its genetic growth potential, or both.

Zinc plays multiple roles in poultry metabolism. At low concentrations, it serves as an essential nutrient and functions as a metal cofactor for several enzymes. Zinc also appears to be directly involved in immune cellular functions and zinc deficiencies might also have indirect consequences on the immune system by failure to limit bacterial infections. Zinc can be taken up by biological systems, and bacterial transport and efflux systems have been identified that are energy dependent and highly regulated. Intestinal uptake is carrier-mediated facilitated diffusion and the mechanism is not well understood.

A few researches showed that supplemental Zn could improve carcass traits of animal. Organic Zn could increase carcass quality grade, marbling, and the fat of pelvis and heart in animals (Greene *et al*., 1988). Zinc consumption also increase body weight of chicken and increase in abdominal fat deposit in female chickens (Butler and Curtis, 1973). Zinc has numerous biological roles including protein metabolism (Blamberg *et al*., 1984), DNA synthesis (Lieberman *et al*., 2001), cell division and multiplication (Rubin, 1972 and Rubin and Koide, 1973) and performance (Sadoval *et al*., 1999), carbohydrate metabolism, and basic functions in growth performance (Mohanna, 1999). Zinc boost immune system (Luecke *et al*., 2001) and it is the only metal essential for at least one enzyme in all six enzyme classes; Oxidoreductase (4 enzymes), transferase (3 enzymes), hydrolase (3 enzymes), ligase (one enzyme), isomerase (one enzyme) as well as ligase (one enzyme) (Kidd *et al*., 1996). As zinc has a direct effect on improving body condition of broiler present study was conducted by using Zis-Vet® that contains zinc sulphate monohydrate.

Despite enormous advances in poultry production and technology, research into trace mineral nutrition has lagged behind than other areas of nutrition. Although zinc has a lot of feasibility to be used as a harmless trace mineral as well as growth promoter for broiler a very few number of researches have been conducted to see the effect of different level of zinc on the broiler diet and there has not been any definite conclusion was drawn regarding its effect on broiler productive performances as well as on their carcass traits. Therefore was conducted with the following objectives-to know the effect of dietary zinc on the productive performances of broiler and to know the effect of dietary zinc on the carcass traits and blood profile of broiler.

II. Materials and Methods

This experiment was conducted with 60 day old (Cobb 500) broilers for a period of 35 days (from 7th May to 10th June, 2016) at the commercial poultry farm of Mr. Mostakim, Karnai, Baserhat, Dinajpur. The aim was to investigate the effect of supplying different level of zinc with the feed to improve the production performances of broilers.

Zinc solution used in this experiment was purchased from local market named Zinc-Vet® (1ml solution contain 2mg zinc sulphate monohydrate USP) which was manufactured and marketed by Navana Bangladesh, Animal health division (a reputed veterinary drugs company), Bangladesh. For the free of cost support, experimental solution was collected from Navana Bangladesh, Anmal health division.

The day old broilers were randomly assigned into 4 dietary treatment groups having 3 replications in each treatment. The treatments were 0, 50, 100 and 150 mg zinc in each kg of feed. There were 5 broilers in each replication. The layout of the experiment is presented in Table 1.

Table 1: Layout showing the distribution of broilers to treatments and replications

Replication	Zinc level (mg/kg feed)				Total
	0 (T_0)	50 (T_1)	100 (T_2)	150 (T_3)	
1	5	5	5	5	20
2	5	5	5	5	20
3	5	5	5	5	20
Total	15	15	15	15	60

Experimental house was divided into 4 parts for four dietary treatment group and each part was subdivided with three parts to facilitate the accommodation of 5 birds in each sub group. Afterr15 days the room was disinfected with PPM solution. The experimental room was thoroughly brushed, swiped and properly washed by water after that bleaching powder @ 1kg/500sq.ft was spread over the floor and it was kept 24 hours without any further attention. The bleaching powder was cleaned by using forced tap water. After that the room was disinfected by TH4+ solution (Manufactured by Sogeval, France, Marketed by-Century Agro Ltd, Bangladesh). Feeders, waterers, buckets and all other necessary equipments were also

properly, washed and disinfected by TH4+ solution. Subsequently dried them and left empty for a week before arrival of chicks. Fresh dried sow dust was used as litter at a depth of 2 cm. All birds were reared under same care and management.

For the first seven days the feed was given in paper and then in small trays. After that feed was supplied in the round feeder. Zinc solution was at first taken by the measuring syringe than mixed with the pellet feed. After mixing the experimental zinc solution to the feed in required amount, feed was supplied to the different group of birds according to their age. Feed was purchased from the Nourish feed company.

Blood was collected from the wing vein of the experimental birds and kept in sterile test tubes containing anticoagulant (EDTA). Then the hematological tests were performed.

The birds were assigned to different experimental groups under Completely Randomized Design (CRD). The data were analyzed by the Statistical Package for Social Science (SPSS) program. The data were expressed as the mean±SEM and significance level were calculated under 5 % level of significance.

III. Results and Discussion

a) Live weight

Live weight of birds during the experimental period is presented in Table 2.Present experiment was started with day old chicks with the average live weight of45±0.19 g. At the 7th day live weight of birds were not significantly differed (P>0.05) among the groups but it was significantly (P<0.05) differed at the 14th, 21st and 28th day of experimental period where higher live weight was observed in the bird fed 150 mg zinc/ kg of feed than the birds of control group (0 mg Zinc/kg feed). Although birds fed 50 and 100 mg Zinc/kg feed showed higher live weight gain but not significantly differed with the control group. At the end of the experiment significantly higher live weight was observed in the birds fed 100 and 150 mg Zinc/kg feed (1494.3 and 1758.53 g, respectively) than the control group (1376.8 g).

It was nay be due to the critical importance of Zinc in maintaining the structure of metallo proteins such as insulin and growth hormone. Results from the growth performance of this study showed that supplemental Zn promoted growth of broilers. Present findings supports the findings of the Ezzati *et al*. (2013) in which they found supplementation of 125 ppm zinc had a significantly higher live weight (2734 g) than the un-supplemented group (2680 g). Liu *et al.* (2012) also found a significant effect in live weight of broiler birds by supplying different level of zinc. Midilli *et al.* (2014) found increasing live weight, while they supplied inorganic and organic form of zinc alone or combination with microbial phytase. Abhishek *et al.* (2016) reported with a significant effect on increase in live weight in groups fed with 80 mg/ kg of zinc from 21-45 days of age, the author found the lowest live weight of birds in control group then the other 4 treatment groups which prove that zinc was essential for growth. Bartlett and Smith (1998) found that a significant increase in live weight of zinc fed broiler occurs than the control group (1576 g vs 1387 g avg. live weight in birds fed adequate and no zinc). Another author Mohanna and Nys (1999) reported that up to 25 mg/kg of zinc supplementation on diet has the effect to increase the live weight.

Table 2: Live weight of birds fed different level of Zinc

Live weight (g) in different time period	Dietary Treatments*				Level of Significance
	T_0	T_1	T_2	T_3	
0 day (day old)	45±0.12	44.8±0.18	45.1±0.21	45.3±0.16	NS
7th day	203^{a}±1.42	202.5±1.91^{a}	202±2.31^{a}	204±2.57^{a}	NS
14th day	385.8±4.54^{a}	467.4±3.48^{b}	442.7±2.21^{ab}	489.4±2.89^{b}	*
21st day	667.8±6.87^{a}	646.8±4.21^{a}	691.7±4.15^{a}	901.13±0.4^{b}	*
28th day	1078.3±6.18^{a}	1163.6±7.4^{a}	1176.5±1.63^{a}	1439.3±5.35^{b}	*
35th day	1376.8±11.42^{a}	1320.3±7.23^{ab}	1494.3±9.14^{b}	1758.53±6.16^{c}	**

The above values represent the mean ± standard error (SE) of the live weight of broiler in different weeks of the experimental period. Mean values with the same superscripts within the same row are statistically non-significant (P>0.05) and Mean values with the different superscripts within the same row are statistically significant (P<0.05)

*Here, T_0= 0 mg Zinc/ kg of feed (Control group), T_1=5 0 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed.

b) Live weight gain

Weight gain of the experimental birds at the day of 35 is shown in Figure 1. It was observed that weight gain at the day of 35 was significantly ($P<0.05$) higher in the birds fed 100 and 150 mg Zinc/kg feed (1249.3g and 1513.53 g, respectively) than the control group T_0 (1131.8 g). However, higher weight gain was also observed in the birds fed 50 g zinc/ kg feed (1175.3 g) but was not significantly different ($P>0.05$) than the control group (1131.8 g). This significant difference in total weight gain is might be due to the association of zinc in protein metabolism of broiler birds. Present findings supports the findings of the Ezzati *et al.* (2013), Liu *et al*. (2012) and Bartlett and Smith (1998), they also found significantly higher live weight gain in the zinc supplemented birds but does not support the findings of the Sahin *et al*. (2005) who had not found any significant differences in the live weight gain of broiler birds by supplying 20 ppm, 40 ppm and 80 ppm dietary zinc to the broiler birds. Midilli *et al.* (2014) found improved live weight gain when they added zinc at the level of 90 mg/kg of diet. Ao *et al.* (2007) also reported that chicks fed as the inorganic form had lower ($P<0.01$) live weight gain.

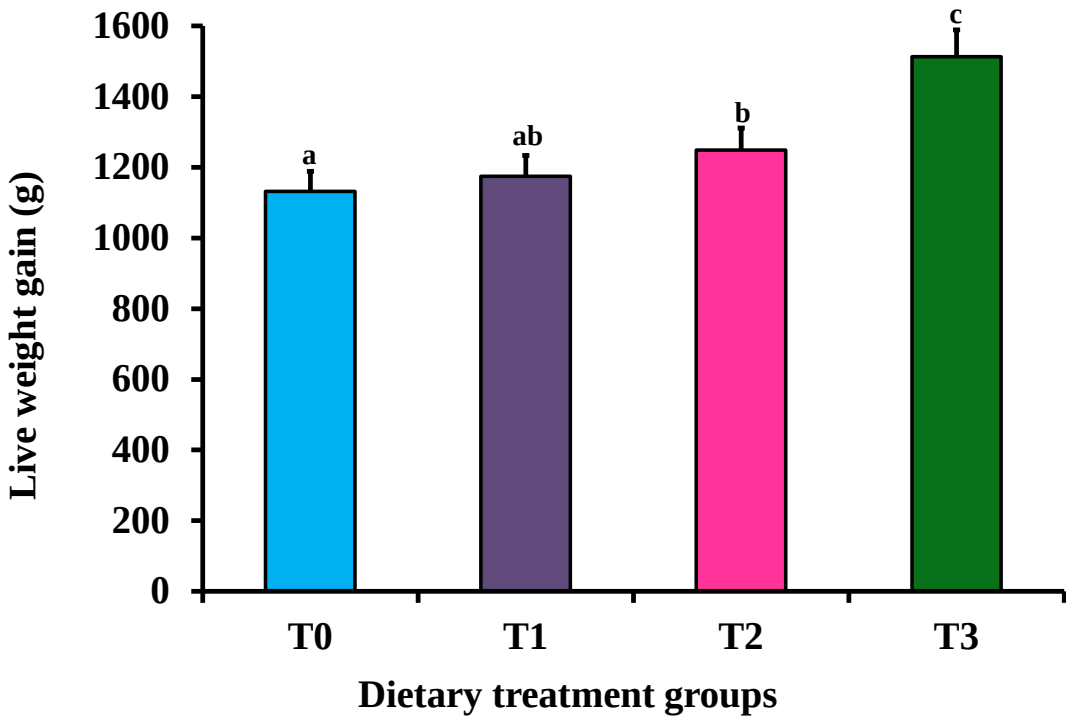


Figure 1: Live weight gain (g) of broiler birds fed different levels of Zinc (T_0= 0 mg Zinc/ kg of feed (Control group), T_1=50 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed). Each bar with error bar represents Mean ± SEM value. Differences were significant ($P<0.01$) among the groups.

c) Feed consumption

Feed consumption of birds during the experimental period is shown in Figure 2. It was observed that feed consumption was significantly ($P<0.05$) higher in the birds fed 100 mg Zinc/kg feed (2717 g/broiler) and 150 mg Zinc/kg feed (2816 g/broiler) than the control group T_0 (2512g). However, higher feed consumption was also observed in the birds fed 50g zinc/ kg feed (2634 g/broiler) but was not significantly differed ($P>0.05$) than the control group (2512 g/broiler). Present findings supports the findings of the Ezzati *et al.* (2013) in which they found supplementation of 125ppm zinc had a significantly higher feed intake (6030 g) than the un-supplemented group (5878 g).

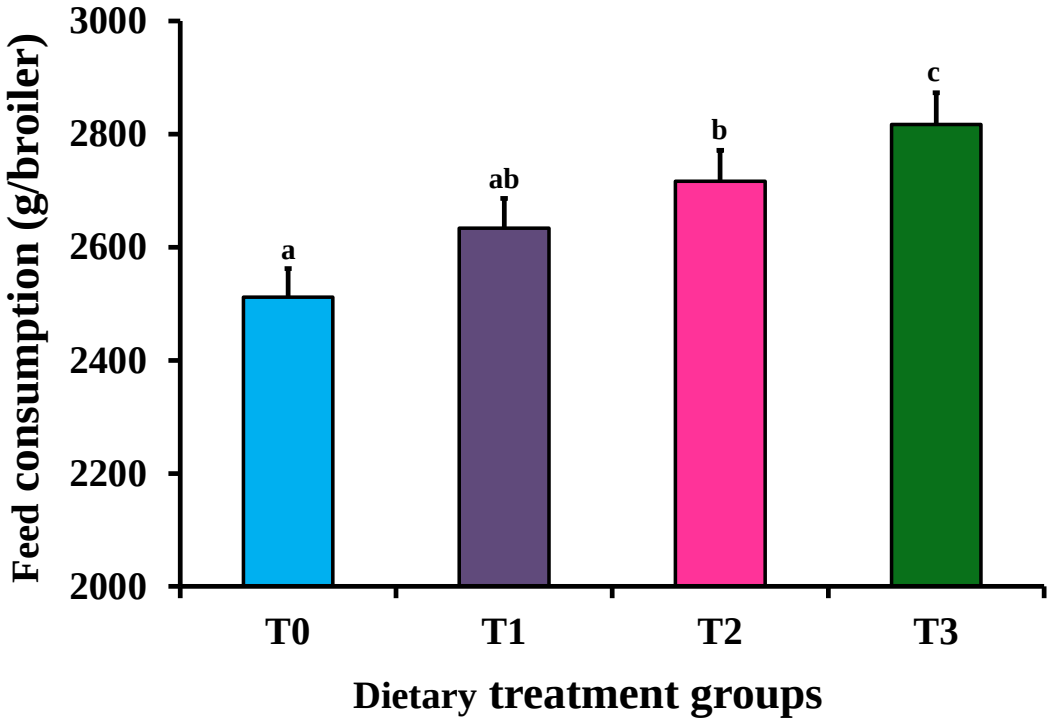


Figure 2: Feed consumption (g/bird) of broiler fed different levels of Zinc (T_0= 0 mg Zinc/ kg of feed (Control group), T_1=50 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed). Each bar with error bar represents Mean ± SEM value. Differences were significant (P<0.01) among the groups.

d) Feed efficiency (FE)

Feed efficiency (FE) of birds during the experimental period is presented in Figure 3. It was observed that FE was significantly (P<0.05) differed between the birds fed 150 mg Zinc/ kg feed (1.79) and control group T_0 (2.13). Birds fed, 50 mg Zinc/kg feed showed slightly higher FE (2.15) than the control group (2.13) but this difference is not statistically significant (P>0.05) . However, birds fed150 mg Zinc/kg feed also showed lower FE (2.09) but was not significantly (P>0.05) differed that of the control group (2.15). Present findings supports the findings of the Hosseini-Mansoub *et al.* (2010) in which they found zinc supplemented bird had a lower FE than the un-supplemented zinc group. Present findings does not supports the findings of the Ezzati *et al*. (2013) in which they found supplementation of 125ppm zinc had a FE 2.15 which was not significantly lower than the un-supplemented zinc group FE (2.15). Huang *et al*. (2007) also found highest FE when zinc was added at the level of 20 mg/kg in diet. Another form of zinc is reported to beneficial for broilers that is zinc-methionine which improves the feed efficiency significantly rather than zinc oxide (Sanford and Kawchumnong, 1972).

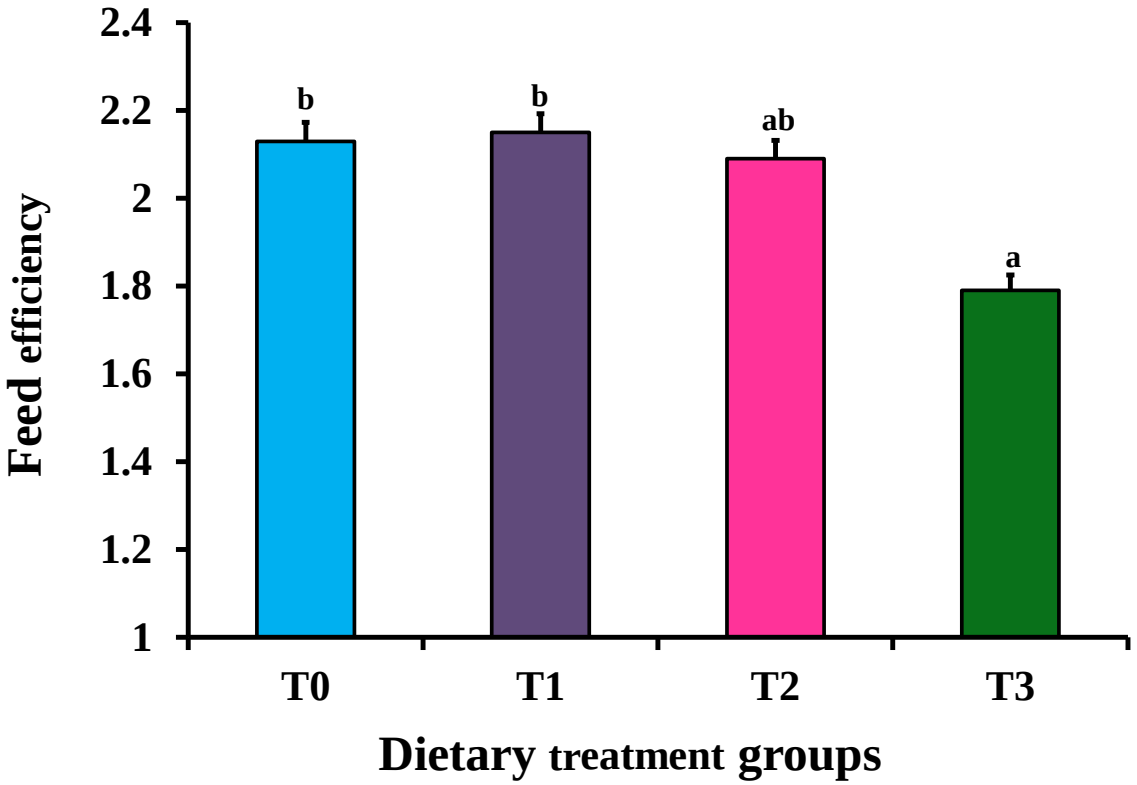


Figure 3: Feed efficiency of broiler birds fed different levels of (T_0= 0 mg Zinc/ kg of feed (Control group), T_1=50 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed). Each bar with error bar represents Mean ± SEM value. Differences were significant (P<0.05) among the groups.

e) Carcass yield

Weight of different internal organs such as heart, gizzard, liver, spleen, pancreas of the birds of T_0, T_1 and T_2 are shown in the Table 3. Statistical analysis of the data did not show any difference between the relative organs weight of the birds of different feeding groups using feed with or without supplementation of Zinc.

Table 3: Carcass characteristics of broiler birds fed different level of Zinc

Parameter (%)	Control	Dietary treatment groups			Level of Significance
	T_0 (n=5) Mean±SE	T_1 (n=5) Mean±SE	T_2 (n=5) Mean±SE	T_3 (n=5)	
Dressing yield	55.90^{a}±1.73	57.45^{ab}±1.35	58.10^{ab}±1.19	61.75^{b}±1.41	*
Breast meat	14.62±1.73	14.81±1.73	14.67±1.73	14.03±1.73	NS
Thigh meat	$8.15^{\pm}0.73^{a}$	8.25 ± 0.13^{a}	8.85 ± 0.81^{ab}	9.33 ± 0.95^{b}	*
Drumstick meat	5.27 ± 0.31^{a}	5.78^{ab}±0.41	5.91^{ab}±0.38	6.43^{b}±0.41	*
Drumstick bone	1.81±1.05	1.93±0.10	1.87±0.12	1.91±0.09	NS
Wing meat	3.22±0.21	3.24±0.38	3.72±0.37	3.79±0.12	NS
Abdominal fat	1.21±0.11	1.19±0.05	1.75±0.03	1.82±0.02	NS
Gizzard	1.44±0.02	1.46±0.05	1.46±0.11	1.51±0.15	NS

Head	2.49±0.16	2.43±0.21	2.48±0.15	2.46±0.17	NS
Heart	0.47±0.005	0.46±0.02	0.47±0.04	0.49±0.09	NS
Liver	2.20±0.12	2.24±0.15	2.18±0.13	2.19±0.08	NS
Neck wt.	1.74±0.03	1.51±0.05	1.86±0.07	1.82±0.07	NS
Wing bone	2.09±0.11	2.25±0.16	2.16±0.12	2.31±0.17	NS
Blood	4.07±0.09	4.09±0.17	4.36±0.12	4.65±0.18	NS
Thigh bone	1.27±0.11	1.24±0.07	1.38±0.09	1.42±0.11	NS
Spleen	0.15±0.002	0.14±0.004	0.12±0.007	0.15±0.002	NS
Skin	8.21±0.53	8.19±0.36	7.96±0.75	8.39±0.81	NS

The above values represent the mean ± standard error (SE) of the live weight of broiler in different weeks of the experimental period. Mean values with the same superscripts within the same row are statistically non-significant (P>0.05) and Mean values with the different superscripts within the same row are statistically significant (P<0.05).
*Here, T_0= 0 mg Zinc/ kg of feed (Control group), T_1=50 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed.

For evaluating carcass yield characteristics dressing yield, breast meat, thigh meat, drumstick meat, drumstick bone, wing meat, abdominal fat, gizzard, head, heart, liver, neck wt., wing bone, blood, thigh bone, spleen and skin were taken as variables. It was observed that except dressing yield, thigh meat and drumstick meat all other variables are not significantly differed among the groups. Dressing yield was highest at birds fed 150 mg zinc/ kg feed while it was 55.90, 57.45 and 58.10 g in T_0, T_1 and T_3 group, respectively. Thigh meat weight was also significantly higher in the birds fed 150 mg zinc/ kg feed while it was 8.15, 8.25and 8.85 g in T_0, T_1 and T_2 group, respectively. Drumstick meat was also significantly higher in weight in the birds fed 150 mg zinc/ kg feed (6.43 g). Thigh meat contains more protein less fat, has less tendon, ligaments, myoglobin and blood vessels than that of dark meat. As a result, digestibility of thigh meat is higher than other meat. The demand is higher for thigh meat than the dark meat.

Thus, thigh meat is the one of the valuable part of broiler. So, difference in thigh and drumstick meat yield is manically important. It is very difficult to explain the mechanism of increasing trend of thigh and drumstick meat yield for groups receiving zinc in feed. Most probably this effect was due to the comparative increase in the live weight of broiler birds fed zinc. Present findings support the findings of the Ezzati *et al.* (2013) in which they also found a significantly higher carcass yield in zinc supplemented birds than the un-supplemented group. But Liu *et al.* (2012) had not found any significant effect in carcass yield characteristics of broiler birds by supplying different level of zinc

f) Blood profile

Hematological parameters of the experimental birds were shown in Table-4. It was found that hemoglobin (g/dl) was not significantly differed (P>0.05) among the different groups of broiler birds (6.50, 6.65, 6.80 and 6.91g/dl respectively in T_0, T_1, T_2 and T_3 group, respectively). Packed cell volume (PCV) was 16.80, 17.10, 17.40 and 17.38 % in T_0, T_1, T_2 and T_3 group, respectively which was not significantly (P>0.05) differed among the groups. Erythrocyte sedimentation rate (ESR) was not significantly differed (P>0.05) among the treatment and control groups and it was 6.67, 6.45, 6.45, 6.65 and 6.67 mm in T_0, T_1 and T_2 group, respectively.

Hb, PCV and ESR value of the birds of different groups does not differ significantly among the groups and it was within the normal range. That indicates that supplementation of zinc has no negative effect on the blood profile of broiler birds that means broiler birds was physically sound and healthy during the experimental period and experimented zinc supplementation was safe for the broiler birds.

Table 4: Hematological parameters of broiler fed different level of dietary zinc

Blood Parameters	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
Hemoglobin (g/dl)	6.50±0.12	6.65±0.06	6.80±0.07	6.91±0.07	NS
PCV (%)	16.80±0.67	17.10±0.49	17.40±0.50	17.38±0.30	NS
ESR (mm in 1st hour)	6.67±0.76	6.45±0.68	6.65±0.63	6.73±0.87	NS

The above values represent the mean ± standard error (SE) of the live weight of broiler in different weeks of the experimental period. Mean values with the same superscripts within the same heading are statistically non-significant (P>0.05) and Mean values with the different superscripts within the same headings are statistically significant (P<0.05)
Here, T_0= 0 mg Zinc/ kg of feed (Control group), T_1=50 mg Zinc/ kg of feed, T_2 = 100 mg Zinc/ kg of feed and T_3= 150 mg Zinc/ kg of feed.

IV. Conclusion

At the end it can be sum up that, zinc can be safely and beneficially used in the broiler diets to improve their productive performances, carcass yield and economic benefit. Present research findings may be useful for the small and large scale poultry farmers to earn more profit through improving broiler performances by using zinc and can contribute in the minimization of national protein need and health hazards by supplying tasty, healthy and antibiotic free broiler meat.

References Références Referencias

1. Abhishek B., Rajeev V. R., Vincent B.-P., Xin T., Chenchen Li, Keji Li, Caroline A. R., Zhanyan Fu, Rudolf J. and Mriganka S. 2016. Jointly reduced inhibition and excitation underlies circuit-wide changes in cortical processing in Rett syndrome. Proceedings of the National Academy of Sciences of the United States of America. 113(46): E7287–E7296.
2. Amin. 2015. Methods for estimation of mineral bioavailability. *Br. Poult. Sci*., 47: 150- 159.
3. Ao, T., Pierce, J. L., Pescatore, A. J., Cantor, A. H., Dawson, K. A., Ford, M. J. and Shafer, B. L. 2007. Effects of organic zinc and phytase supplementation in a maize-soybean meal diet on the performance and tissue zinc content of broiler chicks. *Br. Poult. Sci.* 48: 690–695.
4. Bartlett, J. R., and M. O. Smith. 1998. Effects of different levels of zinc on the performance and immune competence of broilers under heat stress. *Poult. Sci*., 82: 1580-1588.
5. BBS. 2012. Statistical Pocket book of Bangladesh Bureau of Statistics. Ministry of Planning government of the People's Republic of Bangladesh, Dhaka.
6. Bertuzzi, S., G. Manfreda and A. Franchini. 1998. Influence of dietary inorganic zinc and vitamin E on broiler immune response. *Selezione Vet.,* 8(9): 627–636.
7. Blamberg, D. L., U. B. Blackwood, W. C. Supplee, and G. F. Combs. 1984. Effect of zinc deficiency in broiler on body weight and survivability development. *Proc. Soc. Exp. Biol. Med.,* 104: 217–220.
8. Butler, E. and M. Curtis.1973. The effects of Escherichia coli endotoxin and ACTH on the plasma zinc concentration in the domestic fowl. *Research in Veterinary Science,* 15(3): 363-367.
9. Dozier, W. A., A. J. Davis, M. E. Freeman and T. L. Ward. 2003. Early growth and environmental implications of dietary zinc and copper concentrations and sources of broiler chicks. *Br. Poult. Sci.,* 44: 726-731.
10. Ezzati, M., Elio Riboli, M. D. and Lopez, A. D. 2013. Behavioral and Dietary Risk Factors for Noncommunicable Diseases. *N Engl J Med.* 369: 954-964.
11. Farrell, P. R., L. Nicholson, K. D. Roberson, and C.K. Yoong. 2003. Effect of level of inorganic an organic zinc and manganese on the performance and leg abnormalities of turkey toms. *Poult. Sci.,* 71: 18-23.
12. Greene, L. W., D. K. Lunt, and F. M. Byers. 1988. Performance and carcass quality of steers supplemented with zinc oxide or zinc methionine. *J. Anim. Sci.,* 66: 1818–1823.
13. Hosseini-Mansoub, N., Chekani-Azar, S., Tehrani, A.A., Lotfi, A. and Khosravi, M. M. 2010. Influence of dietary vitamin E and zinc on performance, oxidative stability and some blood measures of broiler chickens reared under heat stress (35 °C). *J. Agron*. 2: 103-110.
14. Huang, Y.L., L. Lu, X. G. Luo and B. Liu. 2007. An optimal dietary zinc level of broiler chicks fed a corn-soybean meal diet. *Poult. Sci.,* 86(12): 2582–2589.
15. Kibria ASMG, MA Awal, M Mostofa, AKM Saifuddin, MR Alam and Asgar MA. 2009. Detection of ciprofloxacin and enrofloxacin residues in broilers of

Chittagong. *International Journal of Biological Research,* 2: 33-35.
16. Kidd, M. T., P. R. Ferket, and M. A. Qureshi. 1996. Zinc metabolism with special reference to its role in immunity, *World's Poult. Sci. J.,* 52: 309–324.
17. Lieberman, J. B., S. F. Bilgili, A. M. Parson and K. M. Downs. 2001. Influence of complexed zinc products on live performance and carcass grade of broilers. *J. Appl. Animal Res.,* 19: 49-60.
18. Liu D, SS Guo and YM Guo. 2012. Xylanase supplementation to a wheat-based diet alleviated the intestinal mucosal barrier impairment of broiler chickens challenged by *Clostridium perfringens*. *Avian Pathol.,* 41:291–298.
19. Luecke, Hess, I. B., S. F. Bilgili, A. M. Parson, and K. M. Downs. 2001. Influence of complexed zinc products on live performance and carcass grade of broilers. 3. *Appi. Anim. Res.,* 19:49-60.
20. Midilli, M., Salman, M., Muglali, O. H., Ogretmen, T., Cenesiz, S. and Ormanci. N. 2014. The Effects of Organic or Inorganic Zinc and Microbial Phytase, Alone or in Combination, on the Performance, Biochemical Parameters and Nutrient Utilization of Broilers Fed a Diet Low in Available Phosphorus. World Academy of Science, Engineering and Technology. *Int. J. Bio., Biomol., Agril., Food and Biotech. Engi*. 8(5): 469-475.
21. Mohanna, C. 1999. Effect of dietary zinc content and sources on the growth, body zinc deposition and retention, zinc excretion and immune response in chickens. *Br. Poult. Sci.,* 40: 108-114.
22. Mohanna, C. and Y. Nys. 1999. British Poultry Science, 40(1): 108-114.
23. Rubin, 1972 and Rubin and Koide. 1973. The availability to the chicks of zinc as the sulfate, oxide or carbonate. *Poult. Sci.,* 39: 835-837.
24. Sadoval, Collins and Moran. 1999. Relative bioavailability of supplemental inorganic zinc sources for chicks. *J. Anim. Sci.,* 75: 3195-3205.
25. Sahin, K., M. O. Smith, M. Onderci, N. Sahin, M. F. Garsu and O. Kucuk. 2005. Supplementation of zinc from organic and inorganic source improves performance. *Poult. Sci.,* 84: 882-887.
26. Sanford, P.E. and Kawchumnong, R. 1972. Organic chromium and zinc supplementation of broiler rations. *Poult. Sci.,* 51(suppl. 1): 1856.

This page is intentionally left blank

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Antecedents of Transfer of Post-Harvest Handling Training among Small Scale Bean Grain Farmers in Uganda

By Richard Miiro, Joseph Kiwanuka, Frank Matsiko & Micheal Ugen
Makerere University

Abstract- *Purpose:* The study was conducted to determine the role of transfer factors in influencing the transfer of post-harvest handling training among bean grain farmers, and what differences in the perceptions of the transfer factors existed among participants of varying demography.

Methodology: A sample survey of 301 responded to the Learning Transfer Systems Inventory (LTSI) following translation to a local dialect. Independent T-test, hierarchical multivariate regression, and MANOVA were used to answer the specific issues of the study.

Results: Transfer levels of post-harvest training were high, with women having a significantly higher training transfer than men. 'Motivation to transfer', and 'performance self-efficacy' significantly predicted the outcomes. Participants of primary education rated themselves highly on 'personal capacity to transfer' compared to more educated farmers, while participants of 18 to 35 years rated themselves high on 'readiness to learn' compared to their elders.

Keywords: *training of transfer, transfer system factors, bean grain post-harvest training, uganda.*

GJSFR-D Classification: *FOR Code: 070199*

Strictly as per the compliance and regulations of:

Antecedents of Transfer of Post-Harvest Handling Training among Small Scale Bean Grain Farmers in Uganda

Richard Miiro [α], Joseph Kiwanuka [σ], Frank Matsiko [ρ] & Micheal Ugen [ω]

Abstract- Purpose: The study was conducted to determine the role of transfer factors in influencing the transfer of post-harvest handling training among bean grain farmers, and what differences in the perceptions of the transfer factors existed among participants of varying demography.

Methodology: A sample survey of 301 responded to the Learning Transfer Systems Inventory (LTSI) following translation to a local dialect. Independent T-test, hierarchical multivariate regression, and MANOVA were used to answer the specific issues of the study.

Results: Transfer levels of post-harvest training were high, with women having a significantly higher training transfer than men. 'Motivation to transfer', and 'performance self-efficacy' significantly predicted the outcomes. Participants of primary education rated themselves highly on 'personal capacity to transfer' compared to more educated farmers, while participants of 18 to 35 years rated themselves high on 'readiness to learn' compared to their elders.

Implication: Enhancing the transfer of post-harvest handling of bean grain needs to pay attention to the unique capacity needs of men and women who are involved. Strategies that enhance motivation to transfer and self-efficacy need to be identified, while demographic differences among trainees should inform transfer strategies.

Application: Specific ways of improving planning for training and training transfer design for farmers is critical. One of these is to endeavor to be gender-responsive and ensuring the market viability of interventions to enhance motivation to transfer training.

Originality: The application of the LTSI in a specific training need of African farmers important in farming has been extended, as well as bringing out the gender and demographic factors unique to a context and their implications for transfer design.

Keywords: training of transfer, transfer system factors, bean grain post-harvest training, uganda.

I. Introduction

In Sub Saharan Africa (SSA) despite the large contribution of agriculture to the region's Gross Domestic Product (GDP), agricultural productivity is generally lower than in other developing regions in the world (ACET, 2017). At the same time, agriculture's share in SSA countries' GDP has been declining with an increase in low value-added services, which are unlikely to provide the foundations for sustainable economic development. Linked to this, we find that SSA accounts for the majority of the world's extreme poverty, and most of this extreme poverty is located in rural areas amongst populations dependent on agriculture. This implies that agricultural innovation and transformation will be central to the goal of providing an adequate standard of living to rural populations in SSA countries (ACET, 2017). The development of new technologies, practices, and methods to increase agricultural productivity and enable smallholder farmers to participate and benefit from markets is a priority for sustainable development.

For smallholder farmers to contribute successfully to increased agricultural productivity, and to compete for domestic and global markets, they need training in the use of new technologies and practices. Training will not only improve personal competitiveness, but it is likely to result in improved standards of living and income leading to country-level economic growth. The major objective of any training is to improve personal performance at the workplace that can impact that workplace (Babkina, 2014). While training can have far-reaching positive impacts, it depends a lot on the extent of transfer of the trained knowledge and skills to the workplace. The extent of transfer depends on a system of factors that affect the extent to which the trainee will back to the job and workplace (Baldwin and Ford, 1988; Holton, Bates and Ruona, 2000).

Transfer of training can be defined as the generalization of skills, knowledge, and attitude from the training to the jobs (Iii, Chen, & Naquin, 2003). Studies have shown that trainees often fail to transfer their learning to the workplace. Identifying the extent of transfer and the factors that positively influence the transfer of the skills, knowledge, and attitude acquired from the training into improved work performance is critical at the farm work environment of smallholder farmers in Africa. The extent of transfer reveals the level to which trainees have applied what they have learned back to their job or work context. Additionally, the extent of transfer is influenced by a number of factors inherent in the trainee, the training strategy and the work environment.

Author α σ ρ: Department of Extension & Innovation Studies, School of Agricultural Sciences, College of Agricultural and Environmental Sciences, Makerere University P. O. Box 7062 Kampala, Uganda.
e-mail: josephkiwanuka256@gmail.com
Author ω: National Semi-Arid Resources Research Institute (NaSARRI). National Agricultural Research Organization (NARO) P.O. 56, Soroti, Serere, Uganda.

II. The Learning Transfer System Inventory: Conceptual and Analytical Approach

Holton *et al*., (2000) has argued that the factors that affect training transfer operate as a system. Together with his colleague Bates, they developed the Learning Transfer System Inventory (LTSI) to evaluate the effectiveness of the transfer of training. This would happen through identifying which factors can be responsible for the transfer of training irrespective of the type and place of training. Many studies have used the LTSI to measure the effectiveness of training in various areas and fields.(Kiwanuka, Miiro, Matsiko, & Nkalubo, 2020), used the LTSI to study the effects of trainee and training design characteristics on the transfer of agricultural training in Uganda among bean seed farmers. Soerensen, Stegeager, and Bates (2017) used the LTSI to study the students taking adult vocational training, professional academic programs, diploma, and master's degree training programs in Denmark. Antunes, Nascimento, and Bates (2018), and Velada, Caetano, Bates, and Holton (2009) used the LTSI among private organizations in Portugal. Sseguya, Bekunda, Muthoni, Flavian, and Masigo (2018); Zamani, Ataei, and Bates (2016), Muthoni and Miiro (2016), as well as Miiro, Mazur, and Matsiko (2012) used the LTSI in agricultural training targeting farmers. The LTSI has been used in the public and private sector entities in Ukraine ranging from health, University education, agricultural agencies, high schools, and business (Yamkovenko, Holton and Bates, 2007). It has been to evaluating training in banking in South Africa (Coetsee, Eiselen, & Basson, 2006); among private sector companies working in engineering, construction, financial services, health, telecommunications in German (Bates, Kauffeld, & Holton, 2007), in training related to policing and law enforcement (Hutchins, Nimon, Bates, & Holton, 2013); manufacturing, health, and non-profit international agencies among French-speakers in Belgium (Devos *et al*. 2007), health services in Ireland (Kirwan & Birchall, 2006), private and public sector organizations in Jordan (Khasawneh, Bates and Holton, 2006; Yaghi *et al*., 2007).

In the field of agriculture, transfer of training studies have been scarce (Kiwanuka 2020; Sseguya *et al*., 2018; Zamani, Ataei and Bates, 2016). Yamkovenko *et al*., 2007 study in Ukraine sampled from an agrarian University, and an agricultural academy involved in agricultural extension service. However, their sample was mixed with respondents from other organizations like hospitals, sales, and high schools. Specific studies on the transfer of training in agricultural aspects have been initiated in the last six years. Miiro *et al*. (2012) studied the transfer of governance-facilitation skills by leaders of farmers' marketing organizations in Uganda. Zamani *et al*., 2016, their study in Iran looked at the transfer of over six sustainable agriculture skill sets given to farmers ranging from crop agronomy to milk quality training. Miiro *et al*. (2012) focused on farmer leaders who had received governance-facilitation training while Zamani *et al*., (2016) focused on farmers from clusters that had received training in distinct sustainable agriculture skills. Muthoni and Miiro (2016) focused on the transfer of technical skills like breeding, grain systems and marketing, and on social areas such as gender, monitoring, and evaluation by agricultural scientists working under the auspices of an international agricultural research systems context in Africa. Sseguya *et al*. (2018), looked at the transfer of training of sustainable intensification in agriculture practices (improved crop varieties, good agricultural practices, household nutrition and handling food waste) by farmer trainers in Tanzania. Kiwanuka (2020) looked at the bean agronomic training among bean seed famers.

In terms of the extent of transfer of training in the field of agriculture training transfer levels are high. Zamani *et al*. (2016) registered an 80% transfer of sustainable intensification skills among farmers in Iran. Muthoni & Miiro (2016) who studied 'What influences the transfer of training in an African agricultural research network' registered an average of 75% transfer for each of the four training areas. Miiro et al., (2012) reported 67% transfer of governance-facilitation skills leaders of the farmer marketing organizations. While these rates are high, the factors that influence such outcomes have varied, and so are the implications on how enhancing the transfer of training skill investments. Training transfer studies on agricultural field practices are still few Kiwanuka (2020), Sseguya, *et al*. (2018), and Zamani *et al*. (2016). There is a need to extend research focused on agricultural training among farmers and its transfer in Africa. The level of transfer of training can differ depending on the sex of the trainee. Kingiri (2010) noted that there are unequal relations between men and women in households, men and women have varying challenges in agricultural production, varying opportunities and also play varying roles. These gender differences are bound to affect levels of uptake of agricultural interventions (Mudege, Mwanga, Mdege, Chevo, and Abidin, 2018). Mudege *et al*. (2018) observed fewer women involved in market-oriented sweet potato vine multiplication than the men. From the above literature we hypothesized the following:

H 1: There will be no difference in the transfer of bean grain post-harvest training between men and women farmers

The four training transfer studies in the field of agriculture have looked at actual transfer and explored the factors in the learning transfer system that influence actual transfer as opposed to intended transfer or predictive transfer (Hutchins *et al*., 2013; Zamani *et al*.,

2016). The most common methods of determining the factors that explain transfer of training have involved the use of hierarchical regression given that the influencing factors are categorized into trainee, training design and work environment-related factors (Bates, *et al*., 2007; Velada *et al*., 2007; Miiro *et al*., 2012; Hutchins, *et al*., 2013; Sseguya *et al*., 2018). Zamani *et al*. (2016) on the other hand used path analysis and looked at what influenced the direct transfer of training, and how the explanatory variables related to each other. Both Miiro *et al*. (2012) and Zamani *et al*. (2016) used the LTSI tool while Sseguya *et al*. (2018) used another tool. Respondents in two of the studies were farmer leaders/trainers (Miiro *et al*. 2012; Sseguya *et al*. 2018), while Zamani *et al*. (2016) dealt with farmers directly, with Muthoni and Miiro (2016) dealing with agricultural scientists.

In agriculture-focused training transfer studies, the combination of factors that influenced transfer has differed from one study to another. In Sseguya *et al*. (2018) the combination of predictive factors that were significant in training transfer included 'motivation to learn', 'training design and delivery', and 'work environment' factors. In Muthoni and Miiro (2016) there was no significant contributor to the combination of factors that predicted the transfer of training. Only personal capacity to transfer in the initial block entry of trainee characteristics significantly contributed to transfer. In Miiro *et al*. (2012), 'personal capacity to transfer' in terms of having the mental, physical, knowledge and time to transfer, 'training design and delivery', 'supervisor encouragement' and 'feedback' were critical factors in influencing transfer. In Miiro *et al*. (2012), influencing factors were mainly from work environment while for Zamani *et al*. (2016), they represented trainee and work environment factors ('motivation to transfer', 'performance self-efficacy', 'supervisor support', 'performance-outcomes expectations', 'opportunity to use' and 'supervisor sanctions'). Different influencing factors seem to arise depending on the context, and this means interventions need to be targeted to the unique factors in that special context if the transfer of training is to be enhanced. Given the diversity of the agricultural sector within countries, across countries, the varied levels of capacity building whether governance, policy, managerial, research, business/marketing, extension and farmer level, and the varying skills set across the agricultural value chain, more studies on training transfer are still needed if definite interventions are to be identified.

While it is important to look at the whole system of factors known to affect training transfer (Holton *et al*., 2003), research that focuses on system factors is needed. For example by looking at what individual factors, or what training design factors influence training transfer. Cromwell and Kolb (2004) studied the work environment factors that affected the transfer of supervision skills. Lim (2000), had as one of the objectives identifying the trainee learning and training design factors that influenced the transfer of training albeit he used an open-ended approach of asking the respondents what in the training design supported or inhibited the transfer of training. Some studies have focused on aspects of trainee characteristics that affect the motivation of the trainees (Sahoo and Misra, 2019). Trainee characteristics, and training design and delivery factors that influence the transfer of training were the interest of this study. Work environment factors were presented in another context and expanded to capture the uniqueness of the farmers' work environment.

a) Trainee characteristics and training transfer

The research revealed that the physical, psychological and cognitive ability characteristics of an individual can influence training outcomes. Factors such as; 'Personal capacity to transfer', 'motivation to learn', 'readiness to learn' and 'performance self-efficacy' (See Table 2). According to Tziner *et al*. (2007), trainees who have a high 'performance self-efficacy', are more likely to transfer training than their counterparts with low levels. Trainees with high motivation, prior to training are more likely to transfer training than trainees with low or no motivation (Moreira *et al*., 2019; Pham & Le, 2019; Chiaburu and Marinova, 2005)., Based on these assertions we hypothesize that:

H 2: There will be no difference in the way each of the trainee characteristics contributes to the transfer of bean grain post-harvest training

b) Training design and delivery factors and transfer of training

Training design refers to strategies used to enhance learning and transfer of learning back to the job (Holton, Bates, & Ruona, 2000). Training design factors that influence training transfer include training design (Hutchins *et al*., 2013; Velada *et al*., 2007) and perceived content validity (Bates, Holton, and Hatala, 2012; Ataei and Zamani, 2015). Transfer literature suggests that content design (Bhatti *et al*., 2014; Lim and Morris, 2005) and instructional methods (Yelon, Sheppard, Sleight, & Ford, 1997) are the main categories of training design. Other factors like having general rules and principles to guide application when back to one's job can also affect transfer (Lim & Morris, 2006). Basing on the above assertions we believe it is a significant characteristic in the transfer of training process, thus we hypothesize the following:

H 3: There will be no difference in the way each of the training design factors contributes to the transfer of bean grain post-harvest training

c) Influence of demographic variables on partial LU-LTSI

It is important to note that even within the same training and training transfer context, the demographic

characteristics of the trainees will influence the way the transfer environment is perceived, affecting the level of transfer of training. Hardly any training transfer study in the field of agriculture has considered the demographic differences that create variation in the way respondents view the training transfer system. Will farmers of varied age, sex, education, socioeconomic status, and work experience view the transfer system of factors the same way, and if not what are the implications for training transfer strategizing? Antunes, Nascimento, and Bates (2018) in Portugal, Soerensen, Stegeager and Bates (2017) in Denmark, Velada, Caetano, Bates and Holton (2009) in Portugal, Khasawneh, Bates and Holton (2006) in Jordan, Chen (2006) in Taiwan, Yamnill and McLean (2005) in Thailand have all looked at demographic factors of respondents and how they influenced the way transfer factors were perceived. Trainees of various demographic levels are likely to view training transfer factors differently. Men, for example, tend to view 'performance-outcome expectations' whether positive or negative more positively than women. Respondents of higher age tend to have a lower expectation of 'peer support', 'performance outcomes', and 'coaching'. What demographic differences among agricultural training beneficiaries will influence the perception of the transfer of training factors and what should be done in resultant situations? Petty, Lim, and Zulauf, (2007), examined the gender difference in perception of transfer of related training between CD-ROM-based instruction and traditional based instruction and found no difference in gender. Chen *et al*. (2006), found a significant difference in perception of transfer system characteristics across gender.

H 4: There will be no difference in the way respondents of various gender, age, education, and working experience view the various LTSI factors

d) The Learning Transfer System Inventory conceptual Framework

To begin with, personal factors such as; age, farming experience and level of education are expected to influence the way trainee characteristics and training design is perceived. Depending on the perception, participants will hold on themselves, this will be the level perceived on the transfer of bean post-harvest handling. Trainee characteristics and training design factors of the LTSI finally will influence training transfer of bean agronomic and post-harvest handling.

The arrows indicate how factors influence each other to cause a transfer of training.

e) The Case of Post-harvest handling practices for bean grains

This study focused on a training offered by Community Enterprises Development Organization in Uganda. (CEDO). This was under a research project called pre-cooked beans for food, nutrition, and income(Aseete *et al*., 2018). Farmers were trained on various bean pos- harvest handling practices so that they can produce enough beans to supply the pre-cooked bean industry that aimed at addressing the growing demand of urban and peri-urban consumers (Aseete *et al*., 2018).

CEDO a social enterprise non-government organization engaged farmers in the growing of bean grain under a contract arrangement. It trained farmers in grain production activities, CEDO would buy the bean grain from the farmers at a price that was put in a contract. Farmers were expected to observe the quality standards such as having beans of the same varieties, well dried, clean, not damaged and free from pests. These standards demanded that farmers be trained in bean grain post-harvest handling practices.

The post-harvest practices training took on average 8 hours and covered principles and practices using a hands-on practical approach. Trainers of trainees, selected from different farmer groups, in different villages were trained by a subject specialist. The subject specialists were given smartphones, containing the subject content from which they would select, what to train others. The training which took place two weeks before harvesting included topics like proper drying, winnowing and good storage methods like triple bagging. Weekly radio program on bean farming covering post-harvest handling, was aired out, as information support to farmers. Arrangements were put in place to support farmers who faced any challenge during the production of a bean grain. The arrangements included contacting specialists like extension workers, and some farmers who provided technical backstopping.

III. Methodology

a) Research approach

The study was a quantitative cross-sectional survey design that permitted the determination of factors from the LTSI that influenced the perceived transfer of post-harvest training.

b) Instrumentation

The study adopted) LTSI questionnaire (Holton *et al*., 2000). The tool has been used by several studies; Kiwanuaka(2020); Ataei and Zamani (2015), Bates *et al*. (2007), Devoset al. (2007), and Kirwan and Birchall (2006).Bates, the co-developer of the instrument offered user permission to Dr. Richard Miiro the main -author in this article.

The LTSI was translated into a local dialect called 'Luganda',forming the 'Luganda' Learning transfer system inventory version (LU-LTSI). The LU-LTSI was translated initially from English to Luganda and from Luganda back to English.

The translated LTSI reliability was pretested with 30 farmers in the research population, and factor analyzed. Cronbach's alpha coefficient ranged between 0.7 and 0.8(Table 2). The Independent variable constructs in a local version were measured (Table 1).

Six items were used to measure the dependent variable. Each item was scored on a five-point Likert-type scales with responses ranging from, 1=strongly disagree to 5=strongly agree. The 6 items were;"I enjoy challenges related to bean grain post-harvest practices", "I like to share my ideas on bean grain post-harvest handling with others", "I use more of what I learned in the bean grain post-harvest training", "I am confident that I have progressed since the bean grain post-harvest course", "I am confident about applying the learning from bean grain post-harvest training to my garden", "I have higher expectations from my bean grain post-harvest learning performance since participating in the course". The reliability of these items in measuring transfer was α =0.877. The instrument also collected demographic data. To ensure construct validity, the tool was given to supervisors to assess sentence construction, language clarity and comprehensiveness of the questionnaire, visa-a-vie the set objective in terms of length, the comments were incorporated in the final draft.

c) Study area

The study was conducted in the central Uganda. The mean annual rainfall ranged between 1278 mm-1542 mm in two seasons. The mean daily temperature ranged between 15 °C - 28 °C. The districts had adequate precipitation and relatively fertile soil making agriculture feasible and a major livelihood strategy in the region.

d) Sampling procedure

Rakai and Lyantonde districts were purposively selected based on having the highest levels of bean grain production. Using a random sampling procedure.

e) Data analysis

Quantitative data analysis involved getting factors that gave an interpretable structure of the LTSI used in this study. SPSS for Windows Version16.0 software was used to analyze data.. Principal Axis Factoring (PAF) was used to extract the underlying factor structure of the instrument (Costello & Osbourne, 2005). The measure of sampling adequacy using the Kaiser-Meyer-olkin (KMO) was 0.85, which qualified the data for factor analysis (Coetsee et al., 2006). The Bartlet's test of sphericity was $P < 0.001$. Six factors were extracted explaining 46.9% of the common variance. Items with loadings of greater than 0.4 were selected (Leech, Barrett, & Morgan, 2014) (Table 1).

Independent t-Tests were conducted on all the practices to determine if a difference in score existed in the level of transfer training between men and women that had attended the bean grain post-harvest training.

A hierarchical multiple linear regression analysis was used to determine the combination of factors (trainee, and training design) that influenced the transfer of the training. It was appropriate because the LTSI has three sets of known factors that influence the transfer of training. Thus each set had to be entered as a block to capture the unique factors that contributed to training transfer. Multiple Analysis of Variance (MANOVA) was used to analyze how demographic variables affected perceptions of the LTSI factors. MANOVA was chosen over the univariate analysis of Variance ANOVA. Because, more than one dependent variable could be included simultaneously (Tabachnick & Fidell, 2008). Prior to analysis, data were tested against required assumptions including normality, homoscedasticity, and multicollinearity (Doane & Seward, 2011). Outliers were removed by eliminating z-values from raw data above -/+3.29 (Tabachnick and Fidell, 2008). Descriptive statistics were also used. Levene's F-test was tested (Hair, Black, Babin, Anderson, & Tatham, 2006). Cohen's d for effect size was used (Cohen, 1992)

IV. Results

a) Sample description

Respondents' age ranged from 18 to 82. Close to 72% of the population indicated being between 18 and 50 years old. Similarly, 13% were had no formal education, 55 % had primary education, 23% had secondary education and 9% indicated having post-secondary education. The average land size owned was 5.63(SD= 6.6). The average proportion of land used for bean growing was 2.0 (SD=1.5) acres. The average distance trekked to training centers was 2.6 (SD=2.45) kilometers and the longest distance traveled was 7 kilometers.

Table 1: Factor loading of rotated items

Item	PSE	PCV	MOT	RL	PCT	TD	Communality
Q 83	.768						.564
Q 84	.636						.540
Q 82	.626						.470
Q 85	.593						.466
Q 58		.792					.632
Q 59		.679					.566
Q 49.		.653					.539
Q 48		.613					.540

Q 47		.610					.519
Q 3			.809				.702
Q 5			.782				.622
Q 4			.761				.665
Q 10				.819			.635
Q 9				.778			.586
Q 13				.584			.491
Q 11.					.660		.394
Q 20					.620		.374
Q 12					.549		.346
Q 27					.508		.307
Q 26					.438		.344
Q 54						.556	.494
Q 52						.513	.485
Q 53						.512	.510
Eigen values	9.30	3.67	2.55	1.77	1.62	1.26	
% variance	21.62	8.54	5.92	4.12	3.78	2.92	

PSE =Performance self-efficacy, MOT= Motivation to transfer, PCT= Personal capacity for transfer, PCV =Perceived content validity, RL= Readiness to learn, TD =Training design

Table 2: LU-LTSI scale definitions sample items and cronbach's alphas coefficient

Variable	*Definition*	*Sample item*	*No. of I tem*	*α*
	Train characteristic factors			
Performance self-efficacy	Personal judgment about individual competency to perform defined tasks	I never doubt my ability to use newly learnt skills on the farm	4	0.8
Readiness to learn	The extent to which an individual knows expected outcomes of the training and Understands how the training Is prepared for him or her prior to participating in training	I knew what to expect from the training before it began	3	0.85
Motivation to transfer learning	The individual willingness and excitement to try out new learning to the farm and the belief that new skills will help him or her perform tasks better.	When I left training I couldn't wait to get back to work.	3	0.87
Personal capacity to transfer	Individual belief in overcoming obstacles like lack of time	I did not have time to try to use the knowledge from training	4	0.7
	Training design factors			
Perceived content validity	Individual judgement about the match between training content and job requirements	What was taught closely matched my farming requirement	5	0.8
Training design	Individual perception on how the training was designed to enable them apply what they learnt to the farm	The trainer(s) used lots of examples that showed me how I could use my learning on the farm	3	0.7

Adopted from Kiwanuka et al. (2020)

Table 3: Independent t-Test for the transfer of post -harvest practices by gender

Variable				MEN		WOMEN	
	t-Test	P	Cohen's d	M	SD	M	SD
Use of tarpaulins to dry bean	t(186)=1.48	0.14	0.2	4.37	0.674	4.53	0.73
Winnowing beans before sale	t(250)=2.91	0.01	0.4	4.36	0.678	4.60	0.60
Use of Triple bagging storage method	t(221)=1.19	0.2	0.2	3.61	0.61	3.53	0.62

Note. *Only significant practices are in italics.* M=Mean, P= p-value, SD=standard deviation

b) Level of transfer of bean grain post-harvest training among men and women farmers

The extent of transfer of *bean grain post-harvest* training among men and women farmers were assessed. A statistically significant difference between the mean score of transfer of training for men (n=148, Mean=26.99,SD=3.27) and women (n=101, Mean=27.91, SD=3.01),t (247) =2.26, P=0.025 was obtained. The effect size was a medium effect (Cohen's d = 0.3). The 95% confidence interval in which the true mean lied was -1.73-to -0.12. The assumption of homogeneity of variance was tested and satisfied via Levene's F-test, F=1.41, P=0.24. Independent t-Test was associated with statistically significant effect, thus women transferred more than men.

Winnowing of beans before the sale found to have a statistically significant difference between the mean transfer of training score for men and women (n=151, Mean=26.80, SD=3.39) and women (n=101, Mean=28.01, SD=2.98), t (250) =2.91, P= 0.004. The effect size (Cohen's d = 0.4) was a medium effect.

c) Trainee characteristic factors influencing the transfer of bean grain post-harvest training.

H 2: There will be no difference in the way each of the trainee characteristics influences the transfer of bean grain post-harvest training

Using hierarchical regression modelling, the trainee characteristic factors were entered as a block to determine those which significantly influence the transfer of bean grain post-harvest training (Table 5). These significantly predicted transfer of bean grain post-harvest training (adj.R^2 = 0. 270; F (4, 217) = 21.384, P<0.001). 'Motivation for transfer' (β=0.397, p < 0.001), 'perceived self-efficacy' (β=0.167, p < 0.01) and 'readiness to learn' β=0.153, p < 0.01, significantly contributed to the model.

d) Training design and delivery factors influencing the transfer of bean grain post-harvest training

H 3: There will be no difference in the way each of the training design factors contributes to the transfer of bean grain post-harvest training

In the second step, training design factors ('perceived content validity' and 'training design') were entered as a block to give the final model. The combined and final model significantly predicted the transfer of bean grain post-harvest training (adj.R^2 = 0. 268, F= 14.867, p<0.01). Both trainee characteristics and training design factors explained 27% of the variance in the transfer of training. Trainee characteristic factors emerged as the strongest predictors of bean grain post-harvest training transfer. 'Motivation to transfer' (β=0.394, p< 0.01) and 'performance self-efficacy' (β=0.137, p< 0.05), significantly contributed to the model. None of the training design factors significantly contributed to the transfer of bean grain post-harvest training among the farmers in the final model (Table 5).

Table 4: Hierarchical regression for the transfer of post -harvest training

Dependent variable				
Transfer of post-harvest handling training				
	Model 1	Model 2	Tolerance for model 2	VIF for model 2
Performance self-efficacy	.167**	.137*	.795	1.257
Readiness to learn	.153**	.117	.852	1.174
Motivation to transfer	.397**	.394**	.838	1.194
Personal capacity to transfer	.094	.106	.974	1.027
Perceived content validity	-	.096	.803	1.246
Transfer design	-	.043	.766	1.305
R^2	.283	.293		
Adj.R^2	.270	.274		
F	21.384**	14.867**		
Performance self-efficacy	.167**	.137*	.795	1.257

**P <0.01 * P<0.05

Note VIF Variance inflation factor.

e) Influence of demographic variables on bean grain post-harvest transfer outcome

H 4: There will be no difference in the way respondents of various gender, age, education, and working experience view the various LTSI factors

Multivariate analysis of variance (MANOVA) was conducted to test whether farmer trainees of varying demographics age and education level differed in their perceptions of the factors that influenced the transfer of bean grain post-harvest training.

Education level: MANOVA showed a significant difference across the education levels (Wilk's ∧ =0.893, F = (18, 879) = 1.97, P =0.009, partial η2 =0.039). In the between-subjects, ANOVA showed only one of the

six factors was significant across the education level. The factor was 'personal capacity to transfer' (F: 3,296 = 6.38, P < .001). The strength of association was small partial η2 =0.061 (Table 6). Post hoc examination indicated that respondents with primary education and below rated 'Personal capacity to transfer' higher than did respondents with no formal education. Similarly, respondents with secondary education and above rated 'Personal capacity to transfer' training higher than those with primary education and below.

Table 5: Univariate comparisons of training design and trainee characteristics factors by education level

Dependent Variable	*Education level Means*						
Partial LU-LTSI	*Over all*	*No formal education*	*Primary*	*Secondary*	*Post-secondary*	*F*	*Sig.*
Performance self-efficacy	17.48	16.88	17.87	17.78	17.39	2.03	0.11
Perceived content validity	22.11	22.40	22.84	21.99	21.19	1.01	0.39
Personal capacity to transfer	*14.35*	*12.50*	*12.96*	*15.79*	*16.15*	*6.38*	*0.00*
Training design	13.74	13.60	13.91	13.81	13.62	0.68	0.56
Readiness to learn,	9.99	9.23	10.28	9.81	10.65	0.96	0.41
Motivation to transfer	14.32	14.25	14.47	14.24	14.31	1.46	0.30

Age levels: MANOVA showed no significant difference between the different categories of age groups when considered jointly on the variables of LU-LTSI (Wilk's ∧ =.935, F = (12, 586) = 1.65, P > 0.05, partial η2 = 0.033). In the between-subjects, ANOVA showed a significant difference between the age groups on the factor of 'readiness to learn' (F = (2, 297) =5.77, P < 0.01). The strength of association was very low partial η2 = 0.037 (Table 7). Post hoc comparison across age groups showed that, respondents aged 18 to 38 rated 'readiness to learn' higher than did those aged between thirty-nine and fifty-nine and those older than fifty-nine.

Table 6: Univariate comparisons of training design and trainee characteristics factors by Age groups

	Age (years) means					
Dependent Variable	Over all	18 - 38	39-59	*60 and above*	*F*	Sig.
Performance self-efficacy	17.69	17.94	17.46	17.67	1.37	0.26
Perceived content validity	20.14	14.29	21.86	24.27	2.01	0.14
Personal capacity to transfer	13.72	13.68	14.00	13.47	0.16	0.85
Training design	13.89	13.90	13.70	14.03	1.05	0.35
Readiness to learn,	*10.20*	*10.94*	*9.27*	*10.40*	*5.77*	*0.00*
Motivation to transfer	14.38	14.29	14.43	14.43	0.83	0.43

V. Discussion

This paper addresses a relevant concern on why lessons from most pieces of training in most smallholder farming communities with a focus on improving uptake and scaling of innovations or new practices, are often not taken up in practice in spite of the fact that the pieces of training are initiated based on needs assessments. The results of this study shed light in this direction by highlighting what needs to be taken into consideration and reveals the differences in the level of training transfer between men and women, insights on a combination of trainee characteristics, training design, and trainees' perception of the transfer system.

The extent of skills transfer across gender

This study addressed the question of whether men and women differed with respect to the extent of training transfer of bean grain post-harvest practices. Results indicated that generally, the transfer of training was high with women having higher training transfer than men. This is in line with findings Kiwanuaka (2020) who found out that women, were having a significantly higher training transfer than men. Job & Fajuyigbe (2014), found out that women farmers involved in upland rice growing were more efficient In using technology than men farmers. The possible explanation is that most of the women are often in charge of post-harvest activities of bean grain this means the training they received just reinforced their abilities making it easy for them to transfer in the same line the crop is used as source and women in African cultures are in charge of preparing food for the family hence the high rate of transfer.

Influence of trainee characteristics and training design factors

The result of this study revealed that 'motivation to transfer' was key to the transfer of post-harvest training. This is in agreement with the findings of Kim, Park & Kang, (2019),

Hutchins et al. (2013), Suhepi, (2018) and Zamani *et al*. (2016), who found out that, 'motivation to transfer' had a direct influence on transfer outcome. Since the training took place in the context of commercial bean grain production with a ready buyer of the grain farmers were to produce under a contract arrangement. This might have served as a motivation for those involved in the post-harvest training. Given the role of motivation to transfer in the transfer of training, effort should be made to improve farmers' motivation to ensure better training outcomes.

The results revealed that 'personal self-efficacy' positively influenced training transfer. The finding is consistent with the findings of Zamani *et al*. (2016), Suhepi (2018) and (Velada, Caetano, Michel, Lyons, & Kavanagh, 2007) who found that self-efficacy predicted learning transfer. This finding suggests that self-efficacy was critical if one was to transfer the post-harvest handling skills. This was because those trainee farmers who perceived themselves with higher self-efficacy indicated to have transferred post-harvest training to their farms more.

Effect of demographic variables on partial LU-LTSI

On the demographic influences on the perceptions of the transfer factors, respondents with secondary education and above rated 'personal capacity to transfer' training higher than those with primary education and below. Primary level education rated 'personal capacity to transfer' higher than did respondents with no formal education. Education played an important role in the trainee's understanding of the training and therefore, their perceived capacity to transfer the training. It appears that the post-harvest practices including proper drying, winnowing and good storage methods like triple bagging made more sense and where understandable to farmers who had more education. Implying the importance of education in grasping the aspects that were trained. These findings differ from Antunes *et al*. (2018), Velada *et al*. (2009) who found the more educated trainees had negative perceptions as compared to the less educated. Khasawneh *et al*. (2006) reported lower levels of education have higher levels of motivation to transfer. Velada *et al*. (2009), argued that educated peopletended not to see the value-added in training and were often critical of training goals, designs, and content. It seems since farmers in this study were in farming as a business, continuous learning was important to the advantage of the more educated than not. Farmers who were between 18 to 38 years old rated 'readiness to learn' higher than those aged between thirty-nine and fifty-nine, and those older than fifty-nine. Antunes, *et al*. (2018) also found that younger trainees perceived certain transfer factors more highly and positively. While 'readiness to learn' was not specifically rated highly in their study, young people tend to rate 'performance outcome' whether negative or positive and 'content validity' and 'performance coaching' positively and thus helpful for transferring learning. Unlike the older ones who have gained career stability and value efforts to transfer less. The same arguments work for 'readiness to learn' (Antunes, *et al*., 2018). Younger farmers who were likely to building farming as a business career can have greater readiness to learn, because of the opportunities of making more income.

VI. Creativity

The applicability of LTSI among smallholder farmers in Uganda has been verified, attention to gender differences in the levels of transfer has been made. Demographic factors (age and education) role in influencing farmer trainee perception of transfer system factors among farmers has been highlighted. While most studies have found trainees of higher education apathetic to transfer efforts and not so interested in the outcomes, the study has found out that having an education was useful for farmers to transfer the training. 'Motivation to transfer' and 'performance self-efficacy' were the factors that influenced the transfer of bean grain post-harvest handling training among farmers under the commercial contract based bean grain marketing arrangement. The LTSI has proven its usefulness in assessing whether training is being applied and what can be done to enhance transfer in unique situations. Given that there are countless training targeting farmers and value chain actors, the LTSI is now available as a tool to establish what will make things work irrespective of the context.

VII. Limitation

This study was collected by the self-reporting of the farmers which can be subjective to recall bias and this greatly depends on memory. Respondents generally find it problematic, to remember incidents that happened in the past. Sometimes respondents have the attendance of placing themselves in favorable ways regardless of their actual thoughts and feelings (De Rijdt *et al*. 2013). Measuring actual transfer can improve the findings.

VIII. Conclusions and Recommendations

Training transfer is gendered, and the study showed that women farmers transferred post-harvest handling skills more than men. 'Motivation to transfer' and 'performance self-efficacy' strongly predicted the

transfer of bean grain post-harvest training among the farmers. Age and education level revealed varying perceptions of the transfer system factors among farmers. The young farmers rated 'readiness to learn' higher than the older farmers, while having a higher level of education was important in one's personal capacity to transfer of post-harvest training.

The findings point to some important practical recommendations. The findings suggest that farmers should be highly motivated to transfer the result of the training into the work. Because the farmers are motivated to transfer then transfer will be in line with the purpose of the training. However, if the trainees are not motivated and just came because they were supposed to attend to meet the invitation from the change agent .then the transfer will be low therefore, the facilitator should be able to motivate the farmers and show them how the training is related to their work and how they will apply it on their farms.

Facilitators should also pay more attention to ensuring farmer's self-efficacy this can be achieved by giving more practical examples during the training session, to help the farmers understand how these training outcomes are related to their work. Thus the use of real-life examples and day to day work can build trainees sense of confidence and motivate them to transfer the training to their work

Lastly, it is critical in training and training transfer design to pay attention to the demographic differences of the trainees, and design ways to get the most out of training that suits the demographics of the trainees. This should also guide the selection of who should benefit from training. Policymakers should establish guidelines for training farmers that embrace the critical factors identified in this study.

Acknowledgment

This study was funded by the Australian Centre for International Agricultural Research and the International Development Research Centre (IDRC) project NO.107842 managed by NaCRRI. The authors are grateful to the reviewers who gave good insights into how the paper could be improved.

References Références Referencias

1. African Center for Economic Transformation. (2017). African Transformation Report 2017: Agriculture Powering Africa's Economic Transformation. Retrieved from http://acetforafrica.org/acet/wp-content/uploads/publications/2017/10/ATR17-full-report.pdf%0Ahttp://acetforafrica.org/acet/wp-content/uploads/publications/2017/10/ATR17-overview-english-for-web-0911.pdf
2. Aseete, P., Katungi, E., Bonabana-Wabbi, J., Birachi, E., & Ugen, M. A. (2018). Consumer demand heterogeneity and valuation of value-added pulse products: a case of precooked beans in Uganda. Agriculture & Food Security, 7(1), 51. https://doi.org/10.1186/s40066-018-0203-3
3. Ataei, P., & Zamani, N. (2015). Determinants of the transfer of sustainability learning in agricultural sector of Iran. Journal of Agricultural Science and Technology.
4. Babkina, M. (2014). Training Transfer improvement at organizational level. Retrieved from http://www.theseus.fi/handle/10024/78783
5. Bates, R., Holton, E. F., & Hatala, J. P. (2012). A revised learning transfer system inventory: factorial replication and validation. Human Resource Development International, 15(June 2013), 549–569. https://doi.org/10.1080/13678868.2012.726872
6. Bates, R., Kauffeld, S., & Holton, E. F. (2007). Examining the factor structure and predictive ability of the German-version of the Learning Transfer Systems Inventory. Journal of European Industrial Training. https://doi.org/10.1108/03090590710739278.
7. Chiaburu, D. S., & Marinova, S. V. (2005). What predicts skill transfer? An exploratory study of goal orientation, training self-efficacy and organizational supports. International Journal of Training and Development, 9(2), 110–123. https://doi.org/10.1111/j.1468-2419.2005.00225.x
8. Coetsee, W. J., Eiselen, R., & Basson, J. (2006). Validation of the learning transfer system inventory in the South African context (Part 1). SA Journal of Industrial Psychology, 32(2), 46–55. https://doi.org/10.4102/sajip.v32i2.237
9. Costello, A. B., & Osbourne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment, Research & Evaluation, 10(7), 1–9. https://doi.org/10.1.1.110.9154
10. Doane, D. P., & Seward, L. E. (2011). Measuring Skewness : A Forgotten Statistic ?, 19(2), 1–18.
11. Hair, J. F., Black, W., Babin, B., Anderson, R., & Tatham, R. (2006). Multivariate Data Analysis. Pearson Prentice Hall. (Vol. 6). https://doi.org/10.1080/19447013008687143
12. Holton, E. F. I., Bates, R. A., & Ruona, W. E. a. (2000). Development of a Generalized Learning Transfer System Inventory. Human Resource Development Quarterly, 11(4), 333–360. https://doi.org/10.1002/1532-1096(200024)11:4<333::AID-HRDQ2>3.0.CO;2-P
13. Hutchins, H. M., Nimon, K., Bates, R., & Holton, E. (2013). Can the LTSI predict transfer performance? Testing intent to transfer as a proximal transfer of training outcome. International Journal of Selection and Assessment, 21(3), 251–263. https://doi.org/10.1111/ijsa.12035.

14. Iii, E. F. H., Chen, H., & Naquin, S. S. (2003). An Examination of Learning Transfer System Characteristics Across Organizational Settings, 14(4).
15. Job, O., & Fajuyigbe, A. A. (2014). Technical Efficiency of Men and Women Upland Rice Farmers in Osun State , Nigeria. Journal of Human Ecology, 22(2), 93–100. https://doi.org/10.1080/09709274.2007.11906006
16. Khasawneh, S., Bates, R., Iii, E. F. H., & Holton III, E. F. (2006). Construct validation of an Arabic version of the Learning Transfer System Inventory for use in Jordan. International Journal of Training and Development, 10, 180–194. https://doi.org/10.1111/j.1468-2419.2006.00253.x
17. Kirwan, C., & Birchall, D. (2006). Transfer of learning from management development programmes : testing the Holton model. International Journal of Training & Development, 10(4), 252–268. https://doi.org/10.1111/j.1468-2419.2006.00259.x
18. Kiwanuka, J., Miiro, R. F., Matsiko, F. B., & Nkalubo, S. (2020). Using the Learning Transfer System Inventory to test the effects of trainee and training design characteristics on the transfer of agricultural training in Uganda. https://doi.org/10.1111/ijtd.12202
19. Leech, N. L., Barrett, K. C., & Morgan, G. A. (2014). SPSS for Intermediate Statistics: Use and Interpretation. Igarss 2014. https://doi.org/10.1007/s13398-014-0173-7.2
20. Lim, D. H., & Morris, M. L. (2006). Influence of trainee characteristics, instructional satisfaction, and organizational climate on perceived learning and training transfer. Human Resource Development Quarterly, 17(1), 85–115. https://doi.org/10.1002/hrdq.1162
21. Petty, G. C., Lim, D. H., & Zulauf, J. (2007). Training Transfer between CD-ROM Based Instruction and Traditional Classroom Instruction. Journal of Technology Studies, 33(1), 48–56. Retrieved from http://ezaccess.libraries.psu.edu/login?url=http://search.proquest.com/docview/61857816?accountid=13158%255Cnhttp://media.proquest.com.ezaccess.libraries.psu.edu/media/pq/classic/doc/1342534331/fmt/pi/rep/NONE?hl=&cit%25253Aauth=Petty%25252C+Gregory+C%252
22. Suhepi, A. (2018). THE INFLUENCE OF TRAINING DESIGN, INDIVIDUAL CHARACTERISTICS , AND WORK ENVIRONMENT ON TRAINING TRANSFER AND ITS IMPACT ON EMPLOYEE' S PERFORMANCE, VI(3), 103–123.
23. Tabachnick, B. G., & Fidell, L. S. (2008). Using Multivariate Statistics.
24. Tziner, A., Fisher, M., Senior, T., Weisberg, J., & Street, G. (2007). Effects of Trainee Characteristics on Training Effectiveness, 15(2).
25. Velada, R., Caetano, A., Michel, J. W. J. W. W. J. W., Lyons, B. D., & Kavanagh, M. J. (2007). The effects of training design, individual characteristics and work environment on transfer of training. International Journal of Training and Development, 11(4), 282–294. https://doi.org/10.1111/j.1468-2419.2007.00286.x
26. Yaghi, A., Goodman, D., Holton, E. F., & Bates, R. A. (2007). Validation of the Learning Transfer System Inventory : A Study of Supervisors in the Public Sector in Jordan, 19(3). https://doi.org/10.1002/hrdq
27. Yamkovenko, B. V, Iii, E. H., & Bates, R. A. (2007). of the instrument The Learning Transfer System Inventory (LTSI) in Ukraine The cross-cultural validation of the instrument. https://doi.org/10.1108/03090590710756819
28. Yelon, S., Sheppard, L., Sleight, D., & Ford, J. K. (1997). Intention to Transfer : How Do Autonomous Professionals Become Motivated to Use New Ideas ?, 17(2), 82–103.

This page is intentionally left blank

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 3 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Nutrient use and Response of African Catfish *Clarias Gariepinus* to Fishmeal Diets Containing Auto-Detoxified Mixtures of Jatropha Kernel Cake with Bovine Blood

By Divine. Ewane, Bendicta. O. Oben, Maurice. E. Mele, Kenneth. J. Ngoh Ndamukong, Kingsley. A. Etchu, Eugene. E. Ehabe, Jane. M. Chah, Kennedy. F. Chah & Pius. Mbu Oben

University of Buea

Abstract- African catfish *Clarias gariepinus* fingerlings were used as a model to evaluate diets containing three auto-detoxified mixtures of Jatropha kernel cake with bovine blood (ADMJKC/bb) ingredients. The test ingredients and a control were used to produce seven isonitrogenous and isocalorific diets in which they either replaced 30% or 50% level of fishmeal. The Jatropha kernel cake mixed with bovine blood at a ratio of 2:1; heated, spread dried, remoistened and substituting 30% of fishmeal, and the Jatropha kernel cake mixed with bovine blood at a ratio of 3:1; unheated, spread dried, without remoistening, and substituting 30% of fishmeal), were similar to the control in feed conversion ratio and feed cost per gram of gain.

Keywords: *auto-detoxified, jatropha -kernel -cake bovine -blood, clarias gariepinus.*

GJSFR-D Classification: *FOR Code: 070799*

Strictly as per the compliance and regulations of:

Nutrient use and Response of African Catfish *Clarias Gariepinus* to Fishmeal Diets Containing Auto-Detoxified Mixtures of Jatropha Kernel Cake with Bovine Blood

Divine. Ewane [α], Bendicta. O. Oben [σ], Maurice. E. Mele [ρ], Kenneth. J. Ngoh Ndamukong [ω], Kingsley. A. Etchu [¥], Eugene. E. Ehabe [§], Jane. M. Chah [χ], Kennedy. F. Chah [ν] & Pius. Mbu Oben [θ]

Abstract- African catfish *Clarias gariepinus* fingerlings were used as a model to evaluate diets containing three auto-detoxified mixtures of Jatropha kernel cake with bovine blood (ADMJKC/bb) ingredients. The test ingredients and a control were used to produce seven isonitrogenous and isocalorific diets in which they either replaced 30% or 50% level of fishmeal. The Jatropha kernel cake mixed with bovine blood at a ratio of 2:1; heated, spread dried, remoistened and substituting 30% of fishmeal, and the Jatropha kernel cake mixed with bovine blood at a ratio of 3:1; unheated, spread dried, without remoistening, and substituting 30% of fishmeal), were similar to the control in feed conversion ratio and feed cost per gram of gain. The control significantly out-performed the $Y3_{50}$, $Z2_{50}$ $Z4_{30}$ and $Z4_{50}$ in feed efficiency, indicating thereby that at 30% fishmeal substitution, the 2:1 mixture of Jatropha kernel cake and bovine blood (heated) and the 3:1 mixture of Jatropha kernel cake and bovine blood (unheated) are biologically and economically satisfactory for *C. gariepinus* fingerlings, and could be recommended for *C. gariepinus* industrial rearing.

Keywords: auto-detoxified, jatropha -kernel -cake bovine -blood, clarias gariepinus.

I. Introduction

The African catfish (*Clarias gariepinus*) has served as a good model for evaluating animal feed resources when supplemented with the Jackbean (Osuigwe *et al*., 2005; 2006), poultry viscera (Toutou *et al*; 2018) and soybean meal (Davies and Gouveia, 2008; Abdel-Warith *et al*., 2020). This omnivorous scavenger, particularly amenable to farming practices of peasant small holders in the Tropics and sub-Tropics, was used in this study to test diets containing auto-detoxified mixtures of Jatropha kernel cake (a co-product following extraction of Jatropha oil from *Jatropha curcas* seeds) and bovine blood - ADMJKC/bb (Ewane *et al*; 2017). The Jatropha auto-detoxification process (Ewane *et al*., 2017) and its enrichment with bovine blood (Ewane *et al*., 2021) were meant to maximize the former's benefits to the resource-poor smallholder farmers. This study, which involved in-vitro and in vivo trials, was undertaken to assess the growth, nutrient utilization and economic response of the African catfish fed with diets containing auto-detoxified mixtures of Jatropha kernel cake enriched with bovine blood (ADMJKC/bb) at different levels of fishmeal substitution.

II. Materials and Methods

a) Experimental ingredients and diets

Auto-detoxified mixtures of Jatropha kernel cake and bovine blood (ADMJKC/bb) were produced as described elsewhere (Ewane *et al*., 2021), and three recommended ingredients (Table 1)were tested in iso-calorific and iso-nitrogenous diets, at 30% and 50% replacement levels for fishmeal.

Table 1: Auto-detoxified mixtures of Jatropha kernel cake (JKC) and bovine blood (bb) - ADMJKC/bb

Test ingredients	Code	Description and preparation protocol
Treatment 1	Y3	JKC : bb (2:1 v/v), heated, spread dried, and remoistened daily to 66% w/w dry matter
Treatment 2	Z2	JKC: bb (3:1 v/v) unheated, spread dried without remoistening
Treatment 3	Z4	JKC: bb (3:1 v/v). Unheated, spread dried, and remoistened daily to 66% w/w dry matter

For the purpose of this study, the control treatment was composed of fishmeal, blood meal, maize, palm oil, bone meal, and premix and titanium

Author α σ ρ ω θ: Faculty of Agriculture and Veterinary Medicine, University of Buea, PO Box 63, Buea, Cameroon.
e-mails: ewane.divine@ubuea.cm, obenben2001@yahoo.co.uk, emolua@yahoo.com, etchukingsely@yahoo.com, melleekane@gmail.com, kjnndamukong@yahoo.com
Author ¥ §: Directorate of Scientific Research, Institute of Agricultural Research for Development, P.O. Box 2123, Yaounde, Cameroon.
e-mail: etchukingsely@yahoo.com
Author χ: Faculty of Agriculture, University of Nigeria, Nsukka, Enugu State, Nigeria.
Author ν: Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria.

oxide, without any Jatropha or soybean meal. Whereas all the treatments had the same quantities of blood meal (3% w/w), palm oil (5% w/w), bone meal (1% w/w), titanium oxide (1% w/w) and premix (3% w/w), the quantity of ingredients in each formulation/treatment, given as parts per hundred of fishmeal (Table 2), varied with respect to the quantities of maize (16.2 to 36% w/w), soybean cake (0 to 19.8% w/w), ADMJKC/bb (0 to 25% w/w) and fish meal (25 to 50% w/w).The 30% ADMJKC/bb treatment level was based on the recommendation of Fakunle *et al* (2013) and Alatise *et al* (2014) for a test with *Clarias gariepinus* while the 50% ADMJKC/bb treatment level was based on the recommendation of Kumar *et al* (2011) for a test with carp.

With these ingredients, seven iso-nitrogenous and iso-calorific diets were prepared containing crude protein (38% w/w), metabolis able energy (3000 MCal/kg), and 1% titanium oxide as inert tracer. The materials were thoroughly ground; uniformly using a hammer millthen hand-mixed to produce a mash, and the latter compressed (with a pelletizer) into 2-mm diameter hard pellets. The pellets were sun-dried for 1 h and packaged in dark 50-μm thin polyethylene sheets, and stored at room temperature for eventual use.

Table 2: Composition of experimental diets

Treatments			Ingredients									
Fish meal	ADMJKC/ bb*	Code	Maize	Soybean cake	ADMJKC/ bb	Blood meal	Fish meal	Palm oil	Bone meal	TiO_2	Premix **	Total
100%	Control	-	36	0	0	3	50	5	2	1	3	100
70%	30% Y3	$Y3_{30}$	25	11	15	3	35	5	2	1	3	100
50%	50% Y3	$Y3_{50}$	16.2	19.8	25	3	25	5	2	1	3	100
70%	30% Z2	$Z2_{30}$	32	4	15	3	35	5	2	1	3	100
50%	50% Z2	$Z2_{50}$	29	7	25	3	25	5	2	1	3	100
70%	30% Z4	$Z4_{30}$	26.3	9.7	15	3	35	5	2	1	3	100
50%	50% Z4	$Z4_{50}$	18.5	17.5	25	3	25	5	2	1	3	100

* Auto-detoxified mix of Jatropha kernel cake and bovine blood

** Premix: composed (mg vitamin and mineral/kg premix): vitamin A 4,800,000 IU, vitamin D3 800,000 IU, vitamin E4800 mg, vitamin K 800 mg, thiamine 600 mg, riboflavin 2800 mg, vitamin B3 4800 mg, pyridoxine 600 mg, vitamin B12 4 mg, folic acid 200 mg, cobalt 160 mg, copper 1200 mg, iron 9000 mg, iodine 480 mg, magnesium 2730 mg, manganese 28000 mg, zinc 20000 mg

Table 3 shows that the overall proximate composition of the experimental test ingredients were considerably different in terms of nitrogen-free and ether extracts as well as the ash and crude protein contents and less so in terms of their dry matter and crude fibre contents.

In a similar manner, as opposed to their tannin contents, the overall proximate composition of anti-nutritional factors in the test ingredients were significantly different with respect to phytates content, trypsin inhibitor, saponins, crude phorbol ester and lectin activity (Table 3b).

Table 3: Proximate composition of test ingredients

Figures followed by the same letter in a row were not significantly different (P=5%)

a. *Nutritional factors*

Formulations	Dry matter (%)	Crude protein (%)	Ether extract (%)	Crude fibre (%)	Ash (%)	NFE† (%)
Control						
Treatment1(Y3)	92.09	34.78	39.64	11.56	7.31	5.38
Treatment 2 (Z2)	94.33	50.72	32.89	10.03	5.95	0.41
Treatment 3 (Z4)	93.71	41.81	37.36	11.43	7.16	2.24

b. *Anti-nutritional factors in test ingredients*

Formulations	Phytates (% dry matter)	Trypsin inhibitor (TIU/mg)	Saponins (g/100 g)	Tannin (%)	Crude Phorbol Esther (mg/g)	Lectin activity (mg/mL)
Control						
Treatment 1, Y3	1.71 [a]	3.99 [a]	0.10 [a]	0.044 [a]	0.36 [a]	8.50 [a]
Treatment 2, Z2	1.92 [b]	4.13 [a]	0.11 [a]	0.046 [a]	0.41 [b]	9.13 [b]
Treatment 3, Z4	2.29 [c]	4.31 [b]	0.13 [b]	0.047 [a]	0.47 [c]	9.68 [c]

† NFE = Nitrogen free extract

b) Experimental system and animals

For the feeding trial, modelled after the work of Kumar *et al* (2011), 700 African catfish fingerlings weighing between2.5 and5 g, were obtained from the Batoke-Limbe Station of the Institute of Agricultural Research for Development (IRAD) and transferred to the Ekona Centre of the same institute where feeding trials were conducted. . Hand aerators were used to supply oxygen to the fingerlings during transportation. Upon arrival at Ekona, they were rested for 6 h in two 50-litre tanks, then, randomly split in twenty one (21) groups of 20 fingerlings and each group placed in 35-litre aquaria to acclimatize, over a period of 14 days during which they were fed a commercial diet containing no vegetable protein.

The fish were all starved for 24h before the start of trials, Thereafter, the aquaria were thoroughly washed, rinsed and disinfected. Each fingerling was separately weighed and the five (5) with extreme weights in each group were retrieved and discarded, leaving 15 fingerlings in each tank (experimental unit). Each tank was thus a replicate and three tanks constituted a treatment. About two thirds of the water in each aquarium was siphoned and replaced daily (between 6 am and 8.30 am) with fresh water that had been stored for about 24 hat room temperature in the laboratory. Preliminary measurements showed no detectable levels of nitrite in the water before the start of the experiment. The water quality was monitored regularly and adjustments were made daily (between 3 and 10 pm) to keep the values within optimum range for fresh water fish culture (Temperature of 23-26°C, pH of 7- 8, dissolved oxygen of5 - 6.8 mg/L, conductance of 65.6 – 107 μhom/cm^3, total NH_3 of 0.1 -0.2 mg/L, nitrites of 0.02 – 0.08 mg/L and nitrates of 1–3 mg/L..

The weekly rations of the fish were composed of 5% of their body weight. The daily ration was supplied in five equal parts, and given at five specific periods during the day (9 am, 11.30 am, 2 pm, 4.30 pm and 7 pm), in order to encourage consumption of feed formulations and allow for elimination of less promising treatments. Weight and feed data was recorded for each fish.

Throughout, fish behaviour seemed normal for all the treatments as they were well dispersed and did not always clump into one side of the tank despite routine daily handling. However, fish fed $Z4_{50}$ test ingredient sometimes ate slowly and always left uneaten feed. This behaviour was not observed in the fishes fed the control and other ingredients.

c) Digestibility trial and measurements

The last 14 days of feeding trial were modelled into a digestibility trial during which the inert-marker (titanium dioxide) containing-diets were fed to the fish in accordance with the usual daily schedule. All leftover feed in each aquarium was siphoned (using a pipe) and discarded while the faeces were separately siphoned, poured into labelled beakers, and centrifuged at 4000g. The supernatants were discarded and the sediments (faeces) retrieved and deep-frozen at -20°C for subsequent analysis. Titanium dioxide in feed and faeces were determined using the method of Richter *et al.* (2003) while the nutrients' apparent digestibility coefficients (ADC) and the energy of the various diets were calculated according to (Cho *et al*., 1982). The apparent digestibility coefficients of test ingredients (ADCI) were then calculated based on the digestibility of the reference and test diets using Equations of (Bureau and Cho, 1999),

d) Body composition analysis

From each replicate, twenty (20) fish samples were used for the initial body composition analysis and three (3) for the final body composition analysis. In each case, the fish were sacrificed by immersion in ice slurry, then, autoclaved at 120°C for 10 min, homogenized using a domestic blender and portions retrieved for proximate compositional analysis.

e) Evaluation Parameters

Growth performance and nutrient utilization were assessed in terms of:

- Body mass gain (BMG): The percentage ratio of the change in body mass (Final body mass less Initial body mass) to the initial body mass
- Average daily gain (ADG): The ratio of the change in body mass (final body mass less initial body mass) to the number of trial days
- Specific growth rate (SGR): The percentage ratio of the change in body mass [Ln (final body mass) less Ln (initial body mass)] to the number of trial days

- Interval survival rate (ISR): The ratio of the fish mortality (Initial number of fish less the mortality at midway of Trial) to the initial number of fish
- Final survival rate (FSR): The ratio of the fish mortality (Initial number of fish less the mortality at end of Trial) to the initial number of fish
- Feed conversion ratio (FCR): The ratio of the dry feed intake to the body mass gain
- Protein efficiency ratio (PER): The ratio of the fresh body mass gain to the crude protein fed
- Protein productive value (PPV): The percentage ratio of the change in body protein (Final fish body protein less initial fish body protein) to the total crude protein consumed
- Lipid production value (LPV): The percentage ratio of the change in body lipid (Final fish body lipid less initial fish body lipid) to the total crude lipid consumed
- Metabolic growth rate (MGR):

$$= \frac{\text{Body mass gain in g}}{\left[\left[\frac{\text{Initial body mass in g}/1000^{0.8}+\text{final body mass in g}/1000^{0.8}}{2}\right]\right]}{\text{Number of trial days}}$$

Assuming the market value of a kilogram of *Clarias gariepinus* was 2,000 FCFA (~ 3.64 USD), economic performance was assessed in terms of:

- Cost of feed consumed, which was the product of quantity of feed intake and their unit cost
- Feed cost per gram of gain (USD/g), which was the ratio of the cost of feed consumed to the body mass gain
- Value of live weight gain (in USD), which was a thousandth of the product of the body mass gain and the unit cost of fish
- Economy of gain, which was the ratio of the cost of feed consumed and the value of live-weight gain.

f) Statistical analysis

The experiment was conducted using a Completely Randomized Design and all data were subjected to a one-way analysis of variance using the SPSS Software (IBM Corp., Released 2013). Significant differences between means were detected using the Duncan Multiple Range Test (DMRT).

III. Results

a) Growth performance, survival and feed utilization response to 3ADMJKC/bb ingredient based diets

The initial weights, final weights and body mass gain of *Clarias* fed test diets are shown in Table 4 while the growth performance, survival, feed utilization and feed assimilation are shown in Table: 5. the initial weight of the fishes averaged 2.8±0.19 g. The fishes fed the control diet significantly ($P<0.05$) had higher final weight and body mass gain than those fed the ADMJKC/bb ingredients based diets. The fishes fed the ADMJKC/bb at 30% replacement of fishmeal ($Y3_{30}$, $Z2_{30}$ and $Z4_{30}$) significantly ($P<0.05$)had higher final weights and body mass gains than their counterparts fed 50% level of fishmeal replacement ($Y3_{50}$, $Z2_{50}$ and $Z4_{50}$). However, fishes fed the $Z4_{30}$ ingredient significantly ($P<0.05$)had lower final weights and body mass gains than those fed similar levels of test ingredient Z230 and $Y3_{30}$.

Table 4: Body mass gain of *Clarias gariepinus* fingerlings fed with ADMJKC/bb ingredient based diets for 8 weeks

Treatment*			Initial weight(g)	Final weight (g)	Body mass gain (g)	
Fish meal	Proportion of ADMJKC/bb	Code				
100%	Control *	Control	2.8±0.08	12.20±1.09	9.40± 1.07	d
70%	30% Treatment 1	$Y3_{30}$	2.82±0.08	6.55±0.62	3.72± 0.61	c
50%	50% Treatment 1	$Y3_{50}$	2.92±0.08	4.03±0.46	1.11± 0.51	ab
70%	30% Treatment 2	$Z2_{30}$	2.89±0.12	6.52±0.65	3.63± 0.66	c
50%	50% Treatment 2	$Z2_{50}$	2.92±0.15	3.75±0.17	0.83± 0.27	a
70%	30% Treatment 3	$Z4_{30}$	2.99±0.04	5.09±0.29	2.10± 0.30	b
50%	50% Treatment 3	$Z4_{50}$	2.92±0.08	3.11±0.09	0.19± 0.01	a
Standard error of the mean			0.02	0.65	0.66	

Table 5: Growth performance, survival, feed utilization and feed assimilation of *Clarias gariepinus* fingerlings fed ADMJKC/bb ingredient based diets for 8 weeks

Values (means ± standard deviation) in a column followed by different superscript differ significantly (P < 0.05)

Treatment*			Growth Performance				Survival		Feed Utilization			Feed Assimilation	
Fish meal	Proportion of ADMJKC/bb	Code	Body mass gain (%)	Average daily gain (mg/fish/day)	Specific growth rate (%)	Metabolic growth rate (gkg$^{0.8}$ day^{-1})	Intervals survival rate (%)	Final survival rate (%)	Average daily feed (mg/fish/day)	Feed conversion ratio	Protein efficiency ratio	Protein productive value (%)	Lipid production value (%)
100 %	Control	T0	335±38 ^{d}	168 ± 19^{d}	2.62±0.15^{e}	8.69±0.51^{e}	100±0	82.2±3.9^{ab}	364±6^{e}	2.2±0.2^{a}	1.47±0.17 ^{f}	28.7±3.1 ^{e}	61.3 ± 6.7 ^{a}
70%	30% Treatment 1	$Y3_{30}$	132±22 ^{c}	66 ± 11^{c}	1.50±0.17^{d}	4.90±0.57^{d}	100±0	80.0±0^{a} ^{b}	234±12 ^{d}	3.6±0.4^{a}	0.87±0.11 ^{e}	16.5±1.6 ^{d}	41.0 ± 3.9 ^{a}
50%	50% Treatment 1	$Y3_{50}$	38±18 ^{ab}	20 ± 9^{ab}	0.57±0.24^{b}	1.82±0.78^{b}	98±4	93.3±6.7^{b}	181±12 ^{b}	11.0±0.4 ^{bc}	0.33±0.14 ^{c}	8.2±1.9 ^{b}	20.6 ± 5.2 ^{a}
70%	30% Treatment 2	$Z2_{30}$	126±24 ^{c}	65 ± 12^{c}	1.45±0.20^{d}	4.76±0.65^{d}	100±0	80.0±6.7^{ab}	230±1^{d}	3.6±0.6^{a}	0.85±0.13 ^{e}	16.1±1.9 ^{d}	40.7 ± 4.9 ^{a}
50%	50% Treatment 2	$Z2_{50}$	29±11 ^{c}	15 ± 5^{a}	0.45±0.15^{b}	1.42±0.47^{b}	100±0	84.4±7.7^{ab}	178±5^{b}	13.1±5.3^{c}	0.25±0.08 ^{ab}	7.0±1.1 ^{ab}	14.9 ± 3.0 ^{a}
70%	30% Treatment 3	$Z4_{30}$	70±11 ^{c}	38 ± 6^{b}	0.95±0.11^{c}	3.10±0.36^{c}	100±0	93.9±6.7^{b}	208±15 ^{c}	5.6±0.7^{ab}	0.55±0.07 ^{d}	11.4±1.1 ^{c}	28.8 ± 2.8 ^{a}
50%	50% Treatment 3	$Z4_{50}$	7±0 ^{a}	3 ± 1^{a}	0.11±0.00^{a}	0.35±0.01^{a}	98±4	71.1±19.2^{a}	145±3^{a}	43.0±1.2^{d}	0.07±0.00 ^{a}	4.5±0.1 ^{a}	9.2 ± 0.1 ^{a}
standard error of the mean			23.49	1	0.18	0.59	0.44	2.35	0.01	3.03	0.10	1.72	3.8

There was no significant difference (P>0.05) in final weight and body mass gain among all fishes fed the ADMJKC/bb at 50% level of fishmeal replacement ($Y3_{50}$, $Z2_{50}$ and $Z4_{50}$). However, fishes fed the Y3 ingredient at 50% replacement ($Y3_{50}$) were similar to those fed Z4 ingredient at 30% level of fishmeal replacement ($Z4_{30}$) in body mass gain. The percentage body mass gain and the average daily gains (ADG) followed the same trend as the body mass gains while the specific growth rate (SGR) and the metabolic growth rate (MGR) followed the same trend as the final weights. The $Z4_{30}$ ingredients significantly (P<0.05) induced better SGR and MGR than the $Y3_{50}$ ingredients.

The intermediary survival rates (ISR) were similar (P>0.05) for all the treatment groups including the control. However, $Y3_{30}$ and $Z2_{30}$ had similar final survival rates (FSR) with the control (P>0.05) and these were lower compared to $Y3_{50}$ and Z250 although the differences' were not significant (P>0.05). On the other hand, $Z4_{30}$ significantly (P<0.05) had better final survival rate than $Z4_{50}$.

Average daily feed (ADF) consumption for the control was significantly (P<0.05) higher than the ADMJKC/bb ingredients. The ADMJKC/bb ingredients based diets fed at 30% level of fishmeal replacement were significantly consumed more than their counterparts fed at 50% level of fishmeal replacement. The feed conversion ratio did not significantly (P>0.05) differ between the control and the ADMJKC/bb ingredients based diets fed at 30% level of fishmeal replacement. However, FCR for each ingredient fed at 30% level of fishmeal replacement was significantly (P<0.05) better than the same ingredient fed at 50% level of fishmeal replacement. The protein efficiency ratio (PER) was significantly (P<0.05) higher for the control compared to the ADMJKC/bb. Similarly, the ADMJKC/bb fed at 30% level of fishmeal replacement significantly (P<0.05) had higher PER than their counterparts fed ADMJKC/bb ingredients at 50% level of fishmeal replacement. Protein productive value (PPV) and lipid productive value (LPV) were all significantly (P<0.05) higher for the control than the ADMJKC/bb fed

fish. Also, the ingredients fed at 30% level of fishmeal replacement significantly ($P<0.05$) induced higher PPV and LPV than their counterparts fed at 50% level of fishmeal inclusion. However, $Z4_{30}$ had significantly ($P<0.05$) lower PPV and LPV values than $Z2_{30}$ and $Y3_{30}$.

b) Proximate composition of whole body carcass of Clarias gariepinus

The proximate composition of the whole body carcass of *Clarias gariepinus* fed experiment 6 diets is found in Table 6. The dry matter crude protein, crude fibre and ash contents were not significantly different ($P>0.05$) among the treatments. The ether extract content of the test fish varied from 5.94% for $Z4_{50}$ to 8.12% for the control, but there were no significant difference ($P>0.05$) between the control and the ADMJKC/bb fed fish except for $Z4_{50}$. Similarly, the control and the ADMJKC/bb fed fish were statistically similar in nitrogen free extract (NFE) except the $Z4_{50}$. The control was significantly ($P<0.05$) higher in gross energy compared to the fishes fed higher levels of the test ingredients ($Y3_{50}$, $Z2_{50}$ and $Z4_{50}$).

Table 6: Proximate composition of whole body carcass of *Clarias gariepinus* fingerlings fed ADMJKC/bb Ingredient based diets for 8 weeks

Values (means ± standard deviation) in a column followed by different superscript differ significantly ($P < 0.05$)

Treatment*			Dry matter (%)	Crude protein (%)	Ether extract (%)	Crude fibre (%)	Ash (%)	Nitrogen Free Extract(%)	Gross energy (Kcal/100g)
Fish meal	Proportion of ADMJKC/bb	Code							
Pre-Experimental Fish			72.05 ± 1.41	63.35 ± 1.12	6.02 ± 1.28^{c}	0.14 ± 0.01^{bc}	15.26 ± 1.53^{c}	15.23 ± 3.93^{c}	306.31 ± 1.11^{c}
100%	Control *	Control	76.18 ± 1.19	65.38 ± 0.95	8.12 ± 1.08^{a}	0.15 ± 0.05^{b}	15.44 ± 1.29^{bc}	10.91 ± 1.11^{ab}	323.21 ± 0.94^{a}
70%	30% Treatment 1	$Y3_{30}$	77.52 ± 1.34	65.21 ± 1.06	8.11 ± 1.22^{a}	0.16 ± 0.05^{b}	16.38 ± 1.45^{b}	10.15 ± 1.25^{a}	322.16 ± 1.05^{c}
50%	50% Treatment 1	$Y3_{50}$	77.13 ± 1.07	64.38 ± 0.85	7.52 ± 0.97^{b}	0.17 ± 0.04^{b}	16.52 ± 1.16^{a}	11.41 ± 1.0^{bc}	317.6 ± 0.84^{ab}
70%	30% Treatment 2	$Z2_{30}$	76.18 ± 0.80	65.11 ± 0.64	8.02 ± 0.73^{a}	0.15 ± 0.03^{b}	16.34 ± 0.87^{b}	10.39 ± 0.75^{ab}	322.12 ± 0.63^{c}
50%	50% Treatment 2	$Z2_{50}$	76.91 ± 1.05	64.38 ± 0.83	6.75 ± 0.95^{b}	0.21 ± 0.04^{a}	16.58 ± 1.13^{a}	12.08 ± 0.97^{bc}	314.69 ± 0.82^{bc}
70%	30% Treatment 3	$Z4_{30}$	77.19 ± 1.25	64.75 ± 1.00	7.72 ± 1.14^{b}	0.16 ± 0.05^{b}	16.39 ± 1.36^{b}	10.98 ± 1.17^{ab}	319.72 ± 0.99^{ab}
50%	50% Treatment 3	$Z4_{50}$	76.56 ± 1.21	63.78 ± 0.96	5.94 ± 1.09^{c}	0.22 ± 0.05^{a}	16.56 ± 1.31^{a}	13.51 ± 1.13^{c}	312.92 ± 0.95^{c}
Standard error of the mean			0.23	0.29	0.23	0.01	0.24	0.33	1.32

c) Digestibility of Diets and ADMJKC/bb ingredients

The digestible nutrients and energy of ADMJKC/bb test ingredients are shown in Table 7 The digestible dry matter of the ingredients fed at 30% level of fishmeal replacement was significantly ($P<0.05$) higher for all test ingredients than their counterparts fed at 50% level of fishmeal replacement. The digestible dry matter for Y3 and Z2 was similar ($P>0.05$) at both the 30% and 50% levels of inclusion and significantly ($P<0.05$) superior to Z4 at all the corresponding levels of inclusion.

The digestible crude protein was significantly ($P<0.05$) higher for ingredients fed at 30% level of fishmeal replacements compared to their counterparts fed at 50% level of fishmeal replacement. Specifically, however, the Z2 ingredients had significantly ($P<0.05$) higher digestible crude protein values at both the 30% and 50% levels of fishmeal replacement compared to the Y3 and Z4 ingredients. In the same light, the Y3 ingredients were significantly superior to the Z4 ingredients in digestible crude protein at both the 30% and 50% levels of fishmeal replacement. Irrespective of level of fishmeal replacement, ether extract digestibility was similar for the Z2 and Y3 ingredients which were all significantly ($P<0.05$) superior to the Z4 ingredient at both levels. However, the ether extract digestibility of $Z4_{30}$ was significantly ($P<0.05$) higher than $Z4_{50}$. The digestible energy content followed the same pattern as the dry matter digestibility.

Table 7: Percentage digestible nutrients and energy of ADMJKC/bb test ingredients fed to *Clarias gariepinus* fingerlings in experimental diets

Values (means ± standard deviation) in a column followed by different superscript differ significantly ($P < 0.05$)

Treatment*			Dry matter (%)	Crude Protein (%)	Ether extract (%)	Energy (MCal/kg)
Fish meal	Proportion of ADMJKC/bb	Code				
50%	30% Treatment 1	$Y3_{30}$	42.75 ± 0.84^{d}	84.42 ± 0.59^{d}	63.49 ± 1.34^{c}	64.84 ± 1.12^{d}
50%	50% Treatment 1	$Y3_{50}$	39.27 ± 1.08^{c}	73.98 ± 1.16^{c}	62.52 ± 1.92^{c}	58.39 ± 1.54^{c}
50%	30% Treatment 2	$Z2_{30}$	42.27 ± 0.84^{d}	85.91 ± 0.80^{d}	60.43 ± 1.47^{c}	64.70 ± 1.26^{d}
50%	50% Treatment 2	$Z2_{50}$	39.80 ± 1.32^{c}	83.36 ± 1.27^{d}	59.99 ± 2.59^{c}	59.15 ± 2.04^{c}
50%	30% Treatment 3	$Z4_{30}$	31.31 ± 1.40^{b}	57.60 ± 1.2^{b}	54.21 ± 2.42^{b}	32.37 ± 1.78^{b}
50%	50% Treatment 3	$Z4_{50}$	26.82 ± 1.56^{a}	30.63 ± 1.57^{a}	24.52 ± 3.92^{a}	13.26 ± 4.05^{a}
Standard error of the mean			1.45	4.81	3.33	4.71

d) Economic performance of Clarias gariepinus fingerlings on ADMJKC/bb based diets

The economic performance of *Clarias gariepinus* fingerlings fed ADMJKC/bb based diets is shown in Table 8. The financial value of the body mass gain for the control fish was significantly ($P<0.05$) higher than the fishes fed ADMJKC/bb based diets. The fishes fed 30% level of fishmeal replacement significantly ($P<0.05$) had higher financial value of body mass gain compared to their counterparts fed 50% level of fishmeal replacement, with the exception of the $Z4_{30}$ ingredient which did not differ significantly ($P>0.05$) from its $Z4_{50}$ counterparts. Similarly, the control significantly ($P<0.05$) had higher cost of feed consumed compared to the fishes fed ADMJKC/bb based diets. Also fishes fed ADMJKC/bb based diets at 30% significantly ($P<0.05$) had higher cost of feed consumed than their counterparts fed at 50% level of fishmeal replacement. The cost of feed consumed by $Z4_{30}$ was significantly ($P<0.05$) lower than that of $Z2_{30}$ and $Y3_{30}$. The cost of feed consumed by $Z4_{50}$ was significantly ($P<0.05$) lower than the cost of feed consumed by $Z2_{50}$ and $Y3_{50}$. In the same line the cost of feed consumed by $Z2_{50}$ was significantly ($P<0.05$) lower than the cost of feed consumed by $Y3_{50}$. The control and fishes fed ADMJKC/bb based diets at 30% of fishmeal replacement did not differ significantly ($P<0.05$) in feed cost per gram of gain. However, these fishes fed ADMJKC/bb based diets at 30% level of fishmeal replacement significantly ($P<0.05$) had lower feed cost per gram of gain compared to their counterparts fed ADMJKC/bb based diets at 50% level of fishmeal replacement. The most expensive gains were made by fishes fed $Z4_{50}$ ADMJKC/bb based diets while the least expensive gains were made by the control fishes (compare17.85 fcfa/g to 0.93 fcfa/g). The economy of gain followed the same trend as the feed cost per gram of gain.

Table 8: Economic performance of *Clarias gariepinus* fingerlings fed ADMJKC/bb based diets for 8 weeks.

Values (means ± standard deviation) in a column followed by different superscript differ significantly ($P < 0.05$)

Treatment*			Value of body mass gain (FCFA)	Cost of feed consumed (FCFA)	Feed cost per gram of gain (FCFA/g)	Economy of Gain
Fish meal	Proportion of ADMJKC/bb	Code				
100%	Control *	Control	18.79 ± 2.15^{d}	8.64 ± 0.15^{c}	0.93 ± 0.09^{a}	0.46 ± 0.05^{a}
50%	30% Treatment 1	$Y3_{30}$	7.44 ± 1.24^{c}	5.49 ± 0.27^{a}	1.49 ± 0.18^{a}	0.75 ± 0.09^{a}
50%	50% Treatment 1	$Y3_{50}$	2.22 ± 1.02^{a}	4.27 ± 0.28^{b}	4.62 ± 2.63^{b}	2.31 ± 1.31^{b}
50%	30% Treatment 2	$Z2_{30}$	7.27 ± 1.32^{c}	5.22 ± 0.25^{b}	1.46 ± 0.23^{a}	0.73 ± 0.12^{a}
50%	50% Treatment 2	$Z2_{50}$	1.67 ± 0.55^{a}	3.88 ± 0.12^{a}	5.10 ± 2.06^{b}	2.55 ± 1.03^{b}
50%	30% Treatment 3	$Z4_{30}$	4.20 ± 0.61^{b}	4.83 ± 0.22^{b}	2.32 ± 0.30^{a}	1.16 ± 0.15^{a}
50%	50% Treatment 3	$Z4_{50}$	0.38 ± 0.02^{a}	3.38 ± 0.07^{a}	17.85 ± 0.49^{c}	8.93 ± 0.24^{c}
Standard error of the mean			1.31	0.36	1.26	0.63

Control= Fish meal, blood meal, maize, palm oil, bone meal, premix and Titanium oxide, without any Jatropha meal and soybean meal.

IV. Discussion

The proximate composition of maize, fishmeal, soybean cake and blood meal used in this trial is within normal range and agree with values of Tacon *et al.* (2009). However, the crude protein values for the ADMJKC/bb appear lower than expected. Since bovine blood has more crude protein (81.50%) compared to JKC (29.83%), it was normal to expect that the Y3 ingredient should contain more crude protein than Z2 and Z4, but the converse was observed. Also, Z2 and Z4 were expected to be the same or closer. The difference in crude protein values among the ADMJKC/bb is an indicator that they are not just mixtures of JKC and bovine blood. They have surely undergone biochemical processes which are unique to each mixture. The Y3 and Z4 ingredients were remoistened daily at 66% dry matter while Z2 was not. The Z2 therefore was undergoing a process similar to solid state fermentation. However, the regular remoistening of Y3 and Z4 probably induced a different path of microbial succession that was responsible for the net loss of nitrogen and, consequently, lower crude protein. Such a loss was higher with the Y3 ingredient that had just two parts of JKC compared to the Z4 ingredient that had three parts of JKC. According to Philippot *et al.* (2013), denitrification is the main biological process responsible for the return of fixed nitrogen to the atmosphere, thus completing the N-cycle. Denitrifiers are taxonomically diverse microorganisms capable of reducing soluble nitrogen oxides into the gases N_2O and N_2. It is possible that Y3 and Z4 that were constantly remoistened attracted an active denitrification microbial population that was responsible for its lower than expected crude protein content.

Similarly the microbial succession path undertaken by the Z2 ingredient may be responsible for its comparatively lower level of ether extract. The Z2 ingredient could attract much lipase producing microbes which contribute in lowering the level of ether extract. It is also possible that *J. curcas* lipase activity which is endogenous in dormant and germinating seeds was enhanced by the Z2 treatment. Abigor *et al.* (2002) noted that endogenous *J. curcas* lipase, hydrolyses *J. curcas* oil, at twice the rate for palm kernel and coconut oils. Mendes and Castro (2005) also used commercially available lipase preparations from animal source to decrease fat and organic contents in dairy wastewater.

The anti-nutrients were lowest in Y3, moderate in Z2 and highest in Z4. However, the differences were not significant ($P>0.05$) except for lectin activity, where Z4 was significantly ($P<0.05$) higher than Y3. The lower level of anti-nutrients in Y3 could be as a result of its lower content of JKC in the mixture, or a combination of JKC content and the unique auto-detoxification path taken by this ingredient. However, the difference between Z2 and Z4 was solely dependent on the unique auto-detoxification path taken by each ingredient following the treatment applied.

All the diets which compared three ADMJKC/bb as ingredients at 30% and 50% levels of fishmeal replacement in this study were iso-nitrogenous and iso-calorific, and were similar in proximate composition with the diets for *Clarias gariepinus* reported by Fakunle *et al.* (2013), Alatise *et al.* (2014) and Musiba *et al.* (2014). Slow eating behaviour observed for $Z4_{50}$wassimilar to that reported by Kumar *et al.* (2011) for carp fed a poorly detoxified JKM diet at 75% level.

The control was significantly better than the ADMJKC/bb ingredients in all growth parameters. This was followed by the lower replacement levels of Y3 and Z2 ($Y3_{30}$ and $Z2_{30}$) which recorded similar performance but significantly ($P<0.05$) outperformed the $Z4_{30}$ and the higher replacement levels ($Y3_{50}$, $Z2_{50}$ and $Z4_{50}$). This result is not in agreement with Fakunle *et al.* (2013) and Alatise *et al*. (2014) who reported that a 30% level of including boiled Jatropha in the diets of *Clarias gariepinus* significantly ($P<0.05$)outperformed the control with 0% boiled Jatropha kernels. Several studies (Aregheore, *et al*., 2003; Martınez-Herrera *et al*., 2006; and Gogoi *et al.,* 2014) have concluded that moist heat has no significant effect on reducing phorbolesters which is the main toxic component in jatropha seeds.The poorer performance of the higher replacement levels ($Y3_{50}$, $Z2_{50}$ and $Z4_{50}$) as well as Z4 ingredient irrespective of levels is an indication that ADMJKC/bb ingredients still had some level of toxicity. Detoxified JKM has been reported to contain "residual toxicity". This was detected after a feeding trial with carp which revealed that the sensitivity of the HPLC method for determination of phorbol esters has to be enhanced (Kumar *et al.,* 2011). Working with Carp, Kumar *et al*. (2011) observed highest body mass gain, specific growth rate, and metabolic growth rate and energy production value for the group fed JKM detoxified for 60 minutes and replacing 50% fishmeal. These results were statistically similar to that for the control group and significantly ($P<0.05$) higher than for all test ingredient groups. Therefore, a 50% level of fishmeal replacement by detoxified JKC for *Clarias gariepinus* is achievable since *Clarias gariepinus* like carp is classified more as an omnivore. Moreover, carp is not able to utilize high level (more than 50% of FM protein replacement) of plant derived protein in the diet because of low palatability, high fibre and anti nutrients content (Kumar *et al*., 2011), whereas, *Clarias gariepinus* has recorded good performance on purely plant proteins (Musiba *et al*., 2014).

The intermediary and final survival rates were similar between the control and the ADMJKC/bb ingredients. Also, intake levels did not affect survival except for the Z4 where FSR was significantly ($P<0.05$)lower for $Z4_{50}$ than $Z4_{30}$. This may suggest that the Z4 ingredient retained a higher level of toxicity than

the Y3 and Z2 ingredients. The feed utilization data further buttress this suggestion because the FCR was statistically similar between the control $Y3_{30}$ and $Z2_{30}$ ingredient based diets. In addition, the feed assimilation data indicates that $Y3_{30}$ and $Z2_{30}$ were statistically similar in PPV and LPV, but significantly ($P<0.05$)superior to all other ADMJKC/bb ingredients.

The fish fed ADMJKC/bb based diets were similar ($P>0.05$) in whole proximate composition except in ether extract, NFE and energy where the control was significantly ($P<0.05$) different from the $Z4_{50}$ ingredient based diets. According to Petricorena (2014), chemical composition of fish varies greatly among species and from an individual fish to another, depending on age, sex, environment and season. In this study all other factors were held constant except type and level of ADMJKC/bb ingredients. The differences observed therefore resulted from the test ingredients. There was similarity of this result with the results obtained by Kumar *et al.* (2011) for carp. The higher ether extract and gross energy values for the control and the fishes fed lower levels of ADMJKC/bb ingredients based diets is an indication of better fat deposition in the tissues. At higher levels of inclusion, particularly the Z4 based ingredient, efforts at detoxifying anti-nutrients could contribute in reducing ether extract and gross energy of whole fish carcass. This suggestion is corroborated by the lower PPV and LPV for fish fed higher levels of ADMJKC/bb ingredients. The NFE values followed the same trend as ether extract and gross energy. The only difference is that NFE values were higher where EE and GE values were lower. The NFE values for *Clarias gariepinus* fingerlings recorded in this study are lower than those reported for another type of African catfish (*Heterobranchus bidorsalis*) by Akhirevbulu and Okonji (2013). This difference could be as a result of age and species differences. NFE is a measure of the readily available carbohydrates calculated by subtracting all proximate components from100.Therfore it is likely to suffer from errors compounded in measuring other proximate components.

In the present study, data on digestible nutrients and energy (dry matter, crude protein, ether extract and gross energy) of ADMJKC/bb test ingredients fed indicates that the Z4 ingredient, irrespective of levels, significantly ($P<0.05$) had the lowest digestibility. This therefore reduces its chances of being selected for further development.

The control was significantly ($P<0.05$) superior to the ADMJKC/bb ingredients based diets in terms of the financial value of body mass gain. Conversely, it also significantly ($P<0.05$) recorded a higher cost of feed consumed. However, when evaluated in terms of feed cost per gram of gain as well as the economy of the gain, the control was statistically similar ($P>0.05$) to the $Y3_{30}$ and $Z2_{30}$ ADMJKC/bb ingredients based diets. Feed cost per gram of gain is a parameter that combines biology with economics. It tells if the gains made biologically are financially expensive or not. The similarity of $Y3_{30}$ and $Z2_{30}$ ADMJKC/bb ingredients based diets with the control in feed cost per gram of gain is an indication that these levels of ADMJKC/bb ingredients can be recommended for *Clarias gariepinus* fingerlings. At the $Y3_{50}$ and $Z2_{50}$ levels, the elevated effects of anti- nutrients make it both biologically and economically not feasible for practical diets with *Clarias gariepinus* fingerlings. These results also confirm that the Z4 ADMJKC/bb ingredient is not biologically and economically practical for inclusion into diets of *Clarias gariepinus* fingerlings at either the 30 % or 50% level of fishmeal replacement.

V. Conclusion

Clarias gariepinus fingerlings fed diets containing either Y3 or Z2 ADMJKC/bb diets, where any replaces 30% of fishmeal, have both positive biological and economic performance comparable to the control. At higher levels of 50% fishmeal replacement, biological and economic performance reduces. After this study, the Y3 and Z2 ingredients have been recommended for further development

Abbreviations

ADMJKC/bb: auto-detoxified mixtures Jatropha kernel cake and bovine blood; ANOVA: analysis of variance; ADG: Average daily gain; BMG: Body mass gain; FCR: Feed conversion ratio; FSR: Final survival rate; ISR: Interval survival rate; JKC: Jatropha kernel cake; JKM: Jatropha kernel meal; LPV: Lipid production value; MGR: Metabolic growth rate; NFE: Nitrogen free extract; PER: Protein efficiency ratio; PPV: Protein productive value; SGR: Specific growth rate;Y3:Jatropha kernel cake and bovine blood, mixed at a ratio of 2:1. Heated, spread dried, remoisten to 66% dry matter; Z2: Jatropha kernel cake and bovine blood, mixed at a ratio of 3:1. Unheated, spread dried without remoistening; Z4: Jatropha kernel cake and bovine blood, mixed at a ratio of 3:1. Unheated, spread dried, Remoistened to 66% dry matter.

References Références Referencias

1. Abdel-Warith, A. A., Younis, E. M., Al-Asgah, N. A., & Mahboob, S.. (2020). Effect of replacing fish meal by full fat soybean meal on growth performance, feed utilization and gastrointestinal enzymes in diets for African catfish Clarias gariepinus. Brazilian Journal of Biology, 80(3), 535-543. Epub October 21, 2019.https://doi.org/10.1590/1519-6984.214763
2. Akhirevbulu, C. J. and Okonji, V. A. (2013). Variation of proximate composition, amino acid and fatty acid profiles of parts of cultured Heterobranchus bidorsalis (Geoffroy Saint-Hilaire, 1809). Nigerian Journal of Agriculture, Food and Environment, 9(4):7-12.

3. Alatise SP, Adedokun MA, Adelodun OB and Ajiboye GE (2014). Effects of boiled Jatropha kernel meal as a substitue for soyabeans meal in diet of African Mud Catfish (Clarias gariepinus) fingerlings. Journal of Fisheries and Aquatic Science, 9:446-454 https://dx.doi.org/10.3923/jfas.2014.446.454.
4. Aregheore, E. M., Becker, K. and Makkar, H. P. S. (2003). Detoxification of a toxic variety of Jatropha curcas using heat and chemical treatments, and preliminary nutritional evaluation with rats. South Pacific Journal of Natural Science, 21:50-56.
5. Bureau, D. P and Cho, C. Y. (1999). Measuring digestibility in fish. UG/OMNR Fish Nutrition Research Laboratory Technical Document, University of Guelph, Ontario, Canada. https://pdfslide.net/documents/bureau-and-cho-1999-measuring-digestibility-in-fish-ug-omnr-fish-nutrition-research-laboratory-technical-document.html
6. Cho, C. Y., Slinger, S. J. and Bayley. H. S. (1982). Bioenergetics of salmonid fishes: Energy intake, expenditure and productivity. Comparative Biochemistry, 73B: 25-41.
7. Davies, S. J. and Gouveia, A. (2008). Enhancing the nutritional value of pea seed meals (Pisumsativum) by thermal treatment or specific isogenic selection with comparison to soybean meal for African catfish, Clarias gariepinus. Aquaculture, 283(1–4): 116–122.
8. Ewane D, Oben PM, Ndamukong KJN, Oben BO, Etchu KA and Chah KF (2017). Evaluating auto-detoxification of Jatropha curcas Linnaeus, 1753 kernel cake with brine shrimp Artemiasalina (Linnaeus, 1758) lethality test. African Journal of Biotechnology, 16 (31): 1660-1669. https://doi.org/10.5897/AJB2017.15889
9. Ewane D, Oben BO, Ndamukong KJN, EtchuKA; Ehabe EJ; Chah JM; Chah KF and Oben PM (2021). Toxicity of Auto-Detoxified Jatropha curcas Linnaeus, 1753 Kernel Cake Mixtures With Bovine Blood (ADMJKC/bb) Using Brine Shrimp Artemiasalina Linnaeus, 1758 Online Journal of Animal and Feed Research 9 (1) ISSN 2228-7701
10. Fakunle JO, Alatise SP, Effiong BN and Tiamiyu K (2013). Effects of replacing soyabeans meal with graded levels of boiled Jatropha kernel meal in diets of Clarias gariepinus fingerlings. Bulletin of Environment, Pharmacology and Life Sciences, 2 (9): 112-117.http://www.bepls.com/aug_2013/21.pdf
11. Gogoi, R., Niyogi, U. K. and Tyagi, A. K., (2014). Reduction in trypsin inhibitor activity in Jatropha cake by chemical, thermal and radiation treatment. Research Journal of Chemical Science. 4(1): 17-19.
12. IBM Corp. Released (2013). IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.
13. Jauncey, K. and Ross, B. (1982). A Guide to Tilapia Feeds and Feeding. Institute of Aquaculture, University of Stirling, Stirling, UK, 111 pp.
14. Kasuya, M. C. M., Rodrigues da Luz, J. M., Pereira, L. P da S., Soares da Silva, J., Montavani, H.C. and Rodrigues, M. T. (2013). Bio-detoxification of jatropha seed cake and its use in animal feed http://dx.doi.org/10.5772/45895. Accessed 04/2/2016
15. Kumar, V., Makkar, H. P. S. and Becker, K. (2011). Detoxified Jatropha curcas kernel meal as a dietary protein source: Growth performance, nutrient utilization and digestive enzymes in common carp (*Cyprinus carpio* L.) fingerlings. Aquaculture Nutrition, 17: 313-326.
16. Martinez-Herera, J., Siddhuraju, P., Francis, G., Davila-Ortiz, G. and Becker, K., (2006). Chemical composition, toxic/anti metabolic constituents, and effects of different treatments on their levels, in four provenances of *Jatropha curcas*, from Mexico. Food *Chemistry*, 96: 80-89.
17. Mendes, A. A. and Castro, H. F. (2005). Effect on the enzymatic hydrolysis of lipids from dairy waste water by replacing gum arabic emulsifier for sodium chloride. Brazilian Archives of Biology and Technology, 48: 135-1 42, https://doi.org/10.1590/S1516-89132005000400017
18. Musiba, M. J., Ngupula, G. W., Kashindye, B. B., Elison, M., Shoko, A. P., Ndikumana, J., Zziwa, E. and. Katunzi, E. F. B. (2014). Performance of locally formulated feeds for rearing of African catfish in Tanzania African Crop Science Journal, 22(4): 979 – 986. http://www.bioline.org.br/pdf?cs14050
19. Nyachoti, C. M. de Lange, C.F.M., McBride, B. W. and Schulze, H. (1997). Significances of endogenous gut nitrogen losses in the nutrition of growing pigs: A review. Canadian Journal of Animal Science, 77(1): 149- 163.
20. Osuigwe, D. I., Obiekezie A. I. and Onuoha, G. C. (2005). Some haematological changes in hybrid catfish (Heterobranchus longifilis x Clarias gariepinus) fed different dietary levels of raw and boiled jackbean (Canavalia ensiformis) seed meal. African Journal of Biotechnology, 4(9): 1017–1021.
21. Osuigwe, D. I., Obiekezie, A. I. and Onuoha, G. C. (2006). Effects of jack bean seed meal on the intestinal mucosa of juvenile Heterobranch-uslongifilis. African Journal of Biotechnology, 5(13): 1294–1298.
22. Petricorena, Z. C. (2014). Chemical composition of fish and fishery products. Handbook of Food Chemistry pp 1-28, DIO 10. 1007/978-3-642-41609-5-12-1.
23. Philippot, L., Spor, A., Hénault, C., Bru, D., Bizouard, F., Jones, C. M., Sarr, A. and Maron, P. A. (2013). Loss in microbial diversity affects nitrogen cycling in soil. The ISME Journal, 7(8): 1609–1619. https://www.nature.com/articles/ismej201334/
24. Richter, N.; Perumal Siddhuraju; Becker, K., 2003. Evaluation of nutritional quality of Moringa (Moringa oleifera Lam.) leaves as an alternative protein

source for Nile tilapia (Oreochromis niloticus L.). Aquaculture, 217 (1/4): 599-611
25. Tacon, A. G. J., Metian, M. and Hasan, M. R. (2009). Feed ingredients and fertilizers for farmed aquatic animals: sources and composition. FAO Fisheries and Aquaculture Technical Paper. No. 540. Rome, FAO. 2009. 209p http://www.fao.org/3/i1142e/i1142e.pdf.
26. M Toutou, M., Soliman, A., E. AbdElnabi, H., E. Abouelwafa, A., M. Abdel Rahim, M. (2018).Does feeding African Catfish, Clarias gariepinus vinegar-immersed poultry viscera affect its growth performance, hygienic status and pathogenic bacterial load?. Egyptian Journal of Aquatic Biology and Fisheries, 22(2), 61-76. doi: 10.21608/ejabf.2018.7982
27. Zah, R., Gmuender, S., Muys, B., Achten, W. M. J. and Norgrove, L. (2013). Can Jatropha curcas contribute to climate change mitigation? Jatropha Facts Series, Issue 2, ERA-ARD.

Supporting Information

Table A: Proximate composition and anti-nutritional factors of ingredients used in the feeding trial

Parameter	Ingredient						
	Maize	Fish meal	Soybean Meal	Blood meal	Y3	Z2	Z4
Dry matter (%)	88.40	94.10	94.60	92.00	92.09	94.33	93.71
Crude protein (%)	8.00	66.80	45.20	81.50	34.78	50.72	41.81
Ether extract (%)	5.90	8.10	12.60	3.50	39.64	32.89	37.36
Crude fibre (%)	1.90	1.04	4.98	0.00	11.56	10.03	11.43
Ash (%)	4.20	13.80	6.50	12.36	7.31	5.95	7.16
NFE (%)	80.00	10.26	30.72	2.64	5.38	0.41	2.24
Gross energy (Kcal/100g)	394.3	442.3	419.7	486.0	485.61	460.77	467.74
Anti-nutrients							
Phytates (% dry matter)	ND	ND	ND	ND	1.71	1.92	2.29
Trypsin inhibitor (TIU/mg)	ND	ND	ND	ND	3.99	4.13	4.31
Saponins (g/100 g)	ND	ND	ND	ND	0.10	110	0.125
Tannin (%)	ND	ND	ND	ND	0.044	0.046	0.047
Lectin activity (inverse of mg meal per mL of the assay that produced haemagglutination	ND	ND	ND	ND	8.50	9.13	9.68
CrudePhorbol Esther (mg/g)	ND	ND	ND	ND	0.36	0.41	0.47

ND= Not Determined

Table B: Proximate composition of diets used in feeding trial which compared three ADMJKC/bb as ingredients at 30% and 50% levels of fishmeal replacement

Parameter	Treatment*						
	Control	$Y3_{30}$	$Y3_{50}$	$Z2_{30}$	$Z2_{50}$	$Z4_{30}$	$Z4_{50}$
Dry matter (%)	93.4	93.2	93.1	94.3	94.21	94.3	94.1
Crude protein (%)	38.12	38.02	37.99	38.68	38.08	38.15	38.04
Ether extract (%)	9.15	9.53	9.98	8.43	8.57	9.17	9.53
Crude fibre (%)	3.26	3.11	3.17	3.1	3.12	3.21	3.36
Ash (%)	7.14	8.41	8.53	8.45	8.74	8.39	8.55
NFE (%)	42.33	40.93	40.33	41.34	41.49	41.08	40.52
Metabolisable energy (Kcal/kg)	3032	3014.45	3001.85	3068.1	3091.5	3023.95	3002.5
Cost / Kg (fcfa)	424	415.75	420.65	402.15	390.25	413.75	414.75

Table C: Mean weekly water quality parameters of 35L rectangular tanks used in feeding trial

Week	Temp (°C)	pH	Dissolved Oxygen (mg l^{-1})	Conductance (μhom/cm^3)	NH_3 (mgl^{-1})	Nitrate (mg l^{-1})
1	24.0	7.3	5.8	80.9	0.1	0.8
2	24.5	7.3	5.7	84.8	0.1	0.9
3	24.5	7.4	5.6	85.5	0.1	0.8
4	23.5	7.4	5.7	85.7	0.1	0.8
5	24.5	7.5	5.8	85.7	0.1	0.8
6	24.5	7.6	5.8	85.8	0.1	0.8
7	25.5	7.8	5.8	80.6	0.1	0.8
8	25.0	7.8	5.8	80.6	0.1	0.8

Table D: Apparent Digestibility Coefficients (%) of dry matter, crude protein, ether extract and gross energy of ADMJKC/bb ingredient based diets fed to *Clariasgariepinus* fingerlings

Treatment*	Dry matter Digestibility	Crude Protein Digestibility	Ether Extract Digestibility	Gross Energy Digestibility
Control	$80.31^{c}\pm0.3$	$91.82^{e}\pm0.20$	$93.76^{d}\pm0.53$	$81.65^{d}\pm0.64$
$Y3_{30}$	$71.53^{b}\pm0.7$	$83.97^{d}\pm0.42$	$66.88^{c}\pm0.84$	$72.78^{c}\pm0.80$
$Y3_{50}$	$66.41^{a}\pm0.9$	$79.91^{b}\pm0.83$	$61.12^{b}\pm1.20$	$68.39^{b}\pm1.10$
$Z2_{30}$	$71.16^{b}\pm0.7$	$82.46^{c}\pm0.57$	$66.15^{c}\pm0.92$	$72.58^{c}\pm0.90$
$Z2_{50}$	$66.08^{a}\pm1.1$	$79.57^{b}\pm0.91$	$60.38^{b}\pm1.62$	$68.38^{b}\pm1.46$
$Z4_{30}$	$70.93^{b}\pm1.2$	$81.96^{c}\pm0.87$	$65.88^{c}\pm1.51$	$70.46b^{c}\pm1.27$
$Z4_{50}$	$65.42^{a}\pm1.3$	$73.52^{a}\pm1.12$	$49.62^{a}\pm2.45$	$61.24^{a}\pm2.89$
SEM	1.08	1.15	2.81	1.30

Values are means (n = 3) ± Standard deviation.
Mean values in the same column with different superscript differ significantly ($P < 0.05$)
SEM = standard error of the mean

*Seven treatments designated as follows:
Control= Fish meal, blood meal, maize, palm oil, bone meal, premix and Titanium oxide, without any Jatropha meal and soybean meal.
$Y3_{30:}$=50% of Fish meal replaced by 30% Y3 ADMJKC/bb
$Y3_{50}$=50% of Fish meal replaced by 50% Y3 ADMJKC/bb
$Z2_{30}$=50% of Fish meal replaced by 30% Z2 ADMJKC/bb
$Z2_{50}$=50% of Fish meal replaced by 50% Z2 ADMJKC/bb
$Z4_{30}$= 50% of Fish meal replaced by 30% Z4 ADMJKC/bb
$Z4_{50}$=50% of Fish meal replaced by 50% Z4 ADMJKC/bb

Global Journals Guidelines Handbook 2021

www.GlobalJournals.org

Memberships

Fellows/Associates of Science Frontier Research Council

FSFRC/ASFRC Memberships

Introduction

FSFRC/ASFRC is the most prestigious membership of Global Journals accredited by Open Association of Research Society, U.S.A (OARS). The credentials of Fellow and Associate designations signify that the researcher has gained the knowledge of the fundamental and high-level concepts, and is a subject matter expert, proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice. The credentials are designated only to the researchers, scientists, and professionals that have been selected by a rigorous process by our Editorial Board and Management Board.

Associates of FSFRC/ASFRC are scientists and researchers from around the world are working on projects/researches that have huge potentials. Members support Global Journals' mission to advance technology for humanity and the profession.

FSFRC

Fellow of Science Frontier Research Council

FELLOW OF SCIENCE FRONTIER RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Fellows are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Fellow Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A FSFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Fellows can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Fellows receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Fellows can use the honored title of membership. The “FSFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FSFRC or William Walldroff, M.S., FSFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Fellow members of FSFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All fellows get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Fellows receive discounts on future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Fellows get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows and associates receive access to all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Fellows are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All fellows receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 60% of sales proceeds

Fellows can publish articles (limited) without any fees. Also, they can earn up to 60% of sales proceeds from the sale of reference/review books/literature/ publishing of research paper. The FSFRC member can decide its price and we can help in making the right decision.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Fellow members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

Access to Editorial Board

Become a member of the Editorial Board

Fellows may join as a member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. Additionally, Fellows get a chance to nominate other members for Editorial Board.

Career | Credibility | Exclusive | Reputation

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 5 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 10 GB free secure cloud access for storing research files.

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL is the membership of Global Journals awarded to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A ASFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Associates can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Associates receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Associates can use the honored title of membership. The “ASFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., ASFRC or William Walldroff, M.S., ASFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Associate members of ASFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All associates get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Associates receive discounts on the future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Associates get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows receive access to almost all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All associates receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 30-40% of sales proceeds

Associates can publish articles (limited) without any fees. Also, they can earn up to 30-40% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.

Associate	Fellow	Research Group	Basic
$4800 **lifetime designation**	$6800 **lifetime designation**	$12500.00 **organizational**	APC **per article**
Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
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

INDEX

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896