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Physiology and Functional Biology of Systems

Terry Ansah
Ph.D. student, University for Development Studies-Ghana and Harper Adams University College, **UNITED KINGDOME**
Nutrition - Ruminants

Yadollah Bahrami,
Dep. Anim. Sci., I.A.U., Khorasgan (Isfahan), **IRAN**
Ph.D. Student, Nutrition - Non-Ruminants

Tarlan Farahvash
Dep. Anim. Sci., I.A.U., Khorasgan (Isfahan), **IRAN**
Tarbiat Modares University, Tehran, **IRAN**
Ph.D. Student, Animal Genetic and Breeding

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Growth Performance evaluation of juveniles of *Archachatina marginata* ovum and *Archachatina marginata* saturalis snail subspecies fed forages and their nutrient composition in cross river rainforest zone, Nigeria

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ABSTRACT: *The growth performance characteristics of juveniles of Archachatina marginata ovum and Archachatina marginata saturalis snail subspecies were evaluated using a feeding regime of forages. The forages of choice utilized were: Sweet potato (T1), Cocoyam (T2), Banana (T3), pawpaw (T4) and Okra (T5) respectively. The nutrient composition of these forages was equally determined. Results from this study revealed that juveniles of Archachatina marginata ovum recorded better feed intake than those of Archachatina marginata saturalis. The weight gain showed significant difference (P<0.05) between juveniles of the two subspecies. Results of the feed conversion ratio (FCR) were also significantly different (P<0.05) between the subspecies. Treatment 1 (Sweet potato leaves) recorded overall best result in terms of performance compared to other forages used in this study. Results of proximate composition of forages showed that Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE) and Ash ranged from 75.16 - 79.62%, 10.88 - 12.76%, 14.45 - 19.68%, 16.82 – 69.00%, 31.10 - 32.63% and12.63 - 17.94% respectively. Okra leaves had the highest Dry matter and Ash contents which were significantly different (P<0.05) from other forages. Sweet potato leaves recorded the least Dry matter and Ash contents and the highest Crude protein content while Okra leaves had the least. However, values of CP in sweet potato leaves were significantly different (P<0.05) from Cocoyam and Okra leaves. The EE content in all the forages were relatively low but sweet potato recorded the highest and Okra the least. There was no significant difference (P>0.05) in Ether extract among the forages. Result of CF showed relative increase across the five forages. Banana leaves had the highest value and was significantly different (P<0.05) from those of sweet Potato and pawpaw leaves. The highest NFE content was recorded in sweet potato leaves. There was significant difference (P<0.05) in the Ash content among all the forages except sweet potato. Results from this study were within the normal proximate values of these forages and confirmed that these leaves (plant protein sources) are good forages for farm animals especially micro-livestock like snails and can enhanced optimum growth characteristics.*
Key words: *Growth Performance, Juvenile Snails, Nutrient, Composition, Forages*

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EFFECT OF CLIMATE CHANGE ON DAIRY PRODUCTION IN BOTSWANA AND ITS SUITABLE MITIGATION STRATEGIES

J. C. MOREKI* and C. M. TSOPITO

Department of Animal Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

*E-mail: jcmoreki@gmail.com

ABSTRACT: *This paper explores the effects of climate change on dairy production in Botswana and mitigation strategies are suggested. Dairy farming has not experienced growth over time rendering the country heavily dependent on milk imports. National dairy herd is estimated to be approximately 5000 and per capita consumption of milk about 32.5 litres per person per year. Currently, Botswana is experiencing average high temperatures and low rainfall, frequent droughts and scarcity of both ground and surface water, which all contribute to low livestock and crop productivity. Changes in rainfall patterns, frequent droughts, high incidences of animal diseases (e.g., mastitis and FMD) and parasites, and high environmental temperatures cause significant decrease in livestock productivity. For dairy animals, there is a decline in milk yield and reduced animal weight gain due mainly to high temperatures and inadequate feeds. Mitigation strategies comprise using smaller dairy breeds such as Jersey and Brown Swiss and local Tswana breed, growing fodder crops and utilization of crop residues and constructing cow sheds. Thus, the effects of climate change on dairy cattle production are real and require immediate attention if they are to be minimized or managed properly to attain higher milk production.*

ORIGINAL ARTICLE

Key words: *Botswana, Climate Change, Dairy Production, Greenhouse Gases, Mitigation Strategies*

INTRODUCTION

Climate is an important factor of agricultural production. As a consequence, climate change is expected to affect agricultural and livestock production, hydrologic balances, input supplies and other components of agricultural systems (Aydinalp and Cresser, 2008). The damaging effects of global climate change are increasing and most damages are predicted to occur in developing countries because of their over-reliance on low-input rain-fed agricultural production and their low adaptive capacity (Musemwa et al., 2012). In the opinion of Aydinalp and Cresser (2008), changes in temperature, as well as, changes in rainfall patterns and increased carbon dioxide (CO_2) levels projected to accompany climate change will have important effects on global agriculture, especially in the tropics. Because of erratic rainfall and high incidence of droughts that detrimentally affect crop production, the majority of the rural populace in the developing countries depends on livestock production for their livelihoods (Musemwa et al., 2012). However, the livestock sector is highly vulnerable to climate change. Factors that cause significant losses in livestock are floods, droughts, diseases and poor grazing conditions. Calvosa et al. (2009) stated that many climate change predictions suggest that the African livestock sector will be damaged by 2020.

Botswana's climate is considered subtropical and dry. Rainfall is largely erratic and unreliable resulting in droughts being common. Average daily maximum temperature ranges from 22 ^oC in July to 33 ^oC in January and average daily minimum temperatures from 5 ^oC in July to 19 ^oC in January. Therefore, Botswana's harsh climate supports livestock rearing (including dairy) and wildlife at low densities and dry land cropping in some areas (National Development Plan (NDP) 7 1991). However, ambient temperatures above the thermal neutral zone (>20 ^oC) have detrimental effects on the dairy cows under intensive management (Adin, 2010).

Livestock are known to contribute to greenhouse gas (GHG) emissions. Dairy farming contributes to and is affected by climate change. Dairy production plays a role in GHGs emissions, particularly methane (CH4), which contributes to climate change (Kasulo et al., 2010). The study by Aydinalp and Cresser (2008) showed that most of CH_4 releases come from paddy fields (91%) and less significantly from animal husbandry (7%) and the burning of agricultural wastes (25%). According to Andin (2010), carbon footprints of agriculture and forestry contribute 30% of emission to atmosphere; 5% by all ruminants and 2% by dairy farming. Furthermore, about 50 to 70% of the GHG emission from dairies are originated by CH4 from digestive processes of the cow and manure storage. This paper explores the effects of climate change on dairy production in Botswana. In addition, strategies to be employed to reduce the effect of climate change on dairy production are suggested.

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Effect of climate change on livestock production

The effects of climate change can be direct or indirect. According to Calvosa et al. (2009), the direct effects of climate change include higher temperatures and changing rainfall patterns, which could translate into the increased spread of existing vector-borne diseases and macroparasites, accompanied by the emergence and circulation of new diseases. Climate change could also generate new transmission models in some areas. The indirect effects are attributable to changes in feed resources associated with the carrying capacity of rangelands, the buffering abilities of ecosystems, intensified desertification processes, increased scarcity of water resources and decreased grain production. Other indirect effects are linked to the expected shortage of feed arising from the increasingly competitive demands of food, feed and fuel production, and land use systems (Calvosa et al., 2009). Smit et al. (1996) attributed the indirect effects of climate driven changes in animal performance to mainly alterations in the nutritional environment.

As in other parts of the world livestock farming in Botswana is an important source of income at individual, household and national levels (Nsoso et al., 2009). In addition, livestock are a source of liquid asset, inputs to crop production (draught power and manure), diversification of risk/ buffer to crop production, cultural value (livestock may be sacrificed at the time of a certain festival) and source of food (Conroy, 2005). Dairy farming is an important activity in the lives of Batswana (nationals). Climate change is expected to greatly impact dairy farmers. For instance, crop yields will change due to variations in climate, thus affecting feed costs to farmers. Climatic events such as rising temperatures and atmospheric CO_2 concentrations will change the prices of dairy farms' inputs, including feed, fuel, and electricity. In addition, higher temperatures expose dairy cows to heat stress resulting in a decline in milk yield (Calil et al., 2012). Climate change could affect the costs and returns of livestock production by altering the thermal environment of animals thereby affecting animal health, reproduction, and the efficiency by which livestock convert feed into retained products, especially meat and milk (Key and Sneeringer, 2011). In addition, exposure of livestock to elevated ambient temperature decreases fertility in cattle and pigs especially but also in poultry, rabbits and horses (Nardone et al., (2010). According to Smit et al. (1996), climate change affects animal production in four ways: (a) the impact of changes in livestock feed-grain availability and price; (b) impacts on livestock pastures and forage crop production and quality; (c) changes in the distribution of livestock diseases and pests; and (d) the direct effects of weather and extreme events on animal health, growth and reproduction.

Table 1 - Predicted climate changes in Botswana for period 2008-2037 based on SCENGEN Programme

Variable	Location		Season of the year *				Annual
			Summer	Autumn	Winter	Spring	
Mean Temperature (°C)	Entire country	Value	1.2	1.4	1.3	1.3	1.3
		Range	0.1 to 1.2	0.2 to 1.5	0.3 to 1.4	0.3 to 1.4	0.3 to 1.3
Rainfall (%)	South Western	Value	-0.9	-4.2	-27.5	3.4	10.5
	Eastern	Value	-0.9	-7.3	32.5	-1.1	6.3
	Western	Value	-0.9	-7.3	51.5	-1.1	10.5
		Range	-11.4 to 32.5	-14.2 to 15.7	-11.1 to 54.4	-14.5 to 18.9	-7.7 to 14.2
Cloud cover (%)	Western	Value	0.6	-1.4	2.1	0.2	0.4
		Range	-2.8 to 4.6	-1.8 to 1.2	-3.6 to 3.0	-3.9 to 3.3	-2.5 to 2.4
	Northern and Eastern	Value	-0.1	-1.4	2.1	-0.5	-0.2
		Range	-2.8 to 4.6	-1.8 to 1.2	-3.6 to 3.0	-3.9 to 3.3	-2.5 to 2.4
Wind speed (%)	South Western	Value	1.7	-1.3	1.1	1.3	1.5
		Range	-4.1 to 3.5	-1.4 to 3.2	-1.2 to 2.2	-1.0 to 3.4	-0.9 to 2.7
	Eastern	Value	1.7	2.1	1.1	1.3	1.5
		Range	-4.1 to 3.5	-1.4 to 3.2	-1.2 to 2.2	-1.0 to 3.4	-0.9 to 2.7
Minimum Temperature (°C)	Rest of the country	Value	1.2	1.4	1.5	1.3	1.3
		Range	0.1 to 1.2	0.2 to 1.4	0.3 to 1.5	0.3 to 1.3	0.3 to 1.3
	Northern Botswana	Value	1.2	1.4	1.5	1.3	–
		Range	0.1 to 1.2	0.2 to 1.4	0.3 to 1.5	0.3 to 1.3	
Maximum Temperature (°C)	Western	Value	1.2	1.6	1.1	1.4	1.3
	Eastern and South Western	Value	1.2	1.4	1.1	1.4	–
	Northern	Value	1.2	1.4	1.1	1.5	
		Range	0.2 to 1.2	0.2 to 1.6	0.3 to 1.2	0.3 to 1.5	0.3 to 1.3
Vapour Pressure (hPa)	South Western	Value	0.7	0.5	0.7	0.7	0.7
		Range	0.3-1.7	0.4 to 1.8	0.4 to 1.6	0.3 to 1.6	0.4 to 1.6
	Rest of the country	Value	0.9	0.5	0.7	0.7	0.7
		Range	0.3-1.7	0.4 to 1.8	0.4 to 1.6	0.3 to 1.6	0.4 to 1.6
Diurnal Temperature (°C)	Rest of the country	Value	0.1	0.2	-0.3	0.1	0.0
		Range	-0.6 to 0.1	-0.4 to 0.2	-0.4 to 0.0	-0.1 to 0.2	-0.3 to 0.0
	South western	Value	0.1	0.2	-0.3	0.0	0.0
		Range	-0.6 to 0.1	-0.4 to 0.2	-0.4 to 0.0	-0.1 to 0.2	-0.3 to 0.0

*Summer (December, January, February), autumn (March, April, May), winter (June, July, August) and spring (September, October and November); Source: Nsoso et al. (2009).

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In Botswana, Aganga et al. (2010a) investigated the impact of climate change on water availability and rangeland conditions on animal production and reported that global warming will result in a drier environment that will accelerate the rate of retrogression on rangelands and shift composition to less desirable plants with low nutritional values. Together with lack of grazing management control and overstocking, global warming will also discourage prolificacy and sustenance of the desirable plant species. The dominance of undesirable plant species which are not preferred by livestock will contribute to a decline in livestock productivity.

The SCENGEN Programme was used by Nsoso et al. (2009) to predict climate changes in Botswana for 2008-2037 period. Tables 1 shows that minimum and maximum temperatures will rise over time and across the seasons. Aydinalp and Cresser (2008) reported that higher temperatures in warm regions would likely result in a decline in dairy production, reduced animal weight gain and reproduction and lower feed conversion efficiency. Climate change is also likely to affect the incidence of diseases of livestock and other animals since most diseases are transmitted by vectors such as ticks and flies, the development stages of which are often heavily dependent on temperature. Frequent outbreaks of foot and mouth (FMD) disease in Botswana in recent years could be attributable to climate change. It is argued (Aydinalp and Cresser, 2008) that increasing temperature may also bring beneficial effects in some areas of the world where agricultural production is limited due to low average temperatures by extending the growing season available for plants and by reducing the growing period required by these crops to reach maturity.

Table 1 shows that rainfall in Botswana will decrease from 2008 to 2037, indicating scarcity of grazing resources and stover that is usually used as a feed resource during the dry season. Low rainfall affects crop production and leads to prices of livestock feeds becoming prohibitively expensive. In a study conducted in Botswana, Ethiopia, Ghana and Malawi, Simelton et al. (2011) observed that rainfall was erratic, rains came late or not at all, rainy season was short and ended earlier. The authors ascribed the erratic pattern of rainfall to changes in temperature, wind and wind speed. It is predicted in Table 1 that cloud cover and wind speed will decrease over time.

Dairy production in Botswana

The economy of Botswana is mineral-based with agriculture contributing 1.7% to the gross domestic product (GDP) (NDP 10, 2009). At independence in 1966, the contribution of agriculture to GDP was 40%. Despite its current low contribution to GDP agriculture still plays an important role in the rural economy as a source of employment, food, draught power, animal products and income. About 70% of the rural households derive part of their livelihoods from agriculture. Currently, Botswana is a large importer of agricultural products in the form of fruits, grain, vegetables and products of animal origin such as pork and dairy products.

The dairy industry in Botswana can be categorized into commercial and subsistence sectors. The commercial sector is further sub-divided into small-scale dairy farms that keep 1 to 50 milking dairy cows; medium-scale (51 to 100 milking dairy cows) and large-scale (>100 milking dairy cows). Dairy animals are either kept under intensive, semi-intensive or extensive systems (Ministry of Agriculture, 2013). Mahabile (1997) reported that semi-intensive system predominated with the Friesian being the most popular breed. A recent study by Mahabile and de Waal (2010) in Gaborone Agricultural Region (Botswana) also reported that semi-intensive system is practised by both small-scale and large-scale dairy farmers.

Cattle population in Botswana is estimated to be 2.5 million and dairy cattle account for less than one percent. Department of Animal Production Annual Report (2011/12) estimated the population of dairy cattle to be 4600. Dairy breeds in Botswana include Friesian, Ayrshire, Guernsey, jersey, dairy shorthorn and the dairy Swiss (commonly referred to as Brown Swiss) (Moreki et al., 2011). According to TAHAL Consulting Engineers LTD. (2000), Friesians constitute 47.8% of dairy cattle kept in Botswana followed by Brown Swiss (37%) and others (*e.g.*, Ayrshire, dairy shorthorn, Guernsey and jersey) 5%. Furthermore, Mahabile and de Waal (2010) found the main dairy breeds to be Friesian-Holstein, Jersey, Brown Swiss and crosses. Due to its large size, Friesian requires large amounts of feed in comparison to smaller breeds such as Jersey and Brown Swiss. In addition, Friesian is vulnerable to heat stress which will contribute to reduced feed intake resulting in a decline in milk production. These attributes render Friesian unsuitable for the harsh climatic conditions of Botswana.

National milk production remains very low indicating that the dairy industry is one of the under-performing sectors in Botswana's agriculture. Generally, milk production has not increased over time due to *inter alia* feed shortages (Boitumelo and Mahabile, 1991; Pelaelo-Grand et al., 2010) and use of inappropriate dairy breeds such as Friesian (Ministry of Agriculture, 2013) resulting in a linear increase in imports of fresh raw milk (Table 2). Milk and other milk products are imported from the Republic of South Africa (RSA). On average milk production declined by 110 000 litres per year from 2001 to 2011 while dairy herd increased by 65.5 cows per year. Mahabile (1997) also observed a downward trend in milk production. In 2011, the national dairy herd was estimated to be approximately 4600 while milking cows were slightly over 1000. The decline in the national dairy herd and milking cows over time has resulted in a concomitant decline in milk production, thus rendering the country heavily dependent on imports.

Table 2 shows that milk imports are greater than local milk production, thus providing an opportunity for the dairy sector to either expand or for new projects to be established in order to increase milk yield. The similar sharp increases in milk imports (Table 2) and consumption (Figure 1) in 2006 could possibly be attributed to surplus milk production in RSA that was imported at a lower price. Based on the human population of 2 million (The United Nations Children's Fund, 2012) and milk consumption of 65 008 000 million litres in 2011 (Department of Animal

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Production Annual Report, 2011/12), the *per capita* consumption of milk in Botswana is estimated to be 32.5 litres per person per year.

According to Figure 1, milk consumption increased over time with the highest increase observed in 2006. From 2001 to 2011 milk consumption increased by an average of 1.1 million litres per year, whereas milk production declined by about 110 000 litres per year during the same period. A sharp decline in milk production of 4 800 000 litres (representing 61%) occurred from 2010 to 2011 milk rendering the country heavily reliant on imports.

Table 2 - Dairy cow population, milking cows and milk production and imports from 2001 to 2011

Year	National Dairy Herd	Milking cow	Local milk production (litres)	% Change	Fresh raw milk imports (litres)	% Change
2001	3 936	2 552	4 200 000	36.7	49 518 485	12.3
2002	4 478	1 838	4 700 000	11.9	38 942 493	21.4
2003	5 304	1 763	5700 000	21.3	72 000 000	84.9
2004	5 694	1 779	5 900 000	3.5	35 620 003	-50.53
2005	4 953	1 641	6 300 000	6.8	71 347 909	100.3
2006	5 138	1 707	5 400 000	-14.3	124 047 500	73.86
2007	6 475	1 989	7 700 000	42.6	40 016 570	-67.74
2008	5 348	1 810	7 700 000	0	48 513 732	21.23
2009	6 000	2 000	8 300 000	7.8	40 000 000	-17.55
2010	6 204	1 670	7 900 000	-4.8	38 600 000	-3.5
2011	4 591	1 241	3 100 000	-60.8	61 908 000 est.	60.38

Department of Animal Production Annual Report (2011/12)

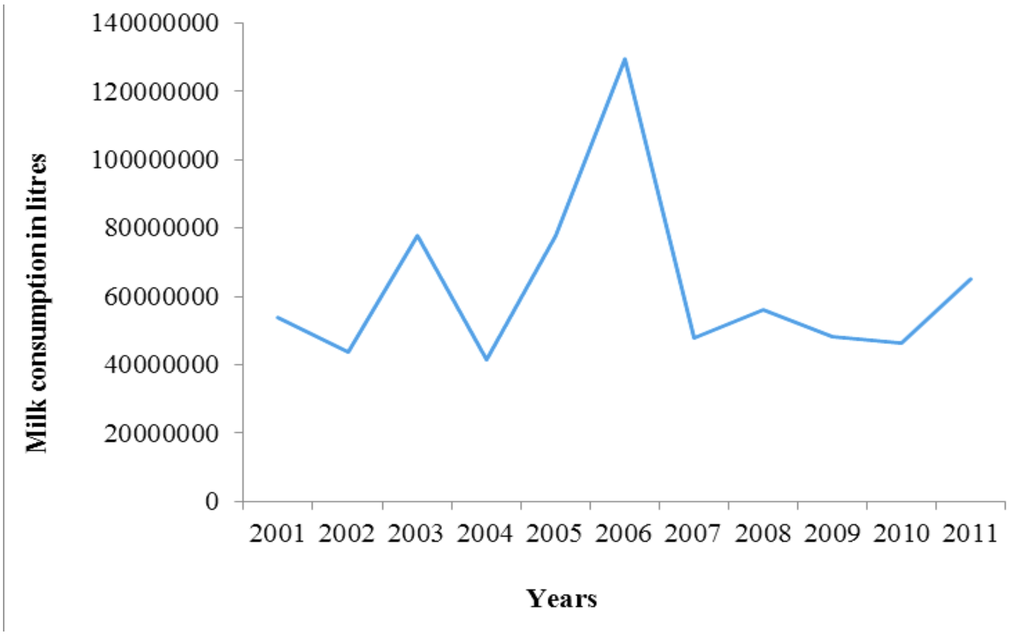

Figure 1 - Milk consumption in Botswana from 2001 to 2011;
Source: Department of Animal Production Annual Report (2011/12)

Mitigation strategies

Climate change necessitates employing strategies that will alleviate the impacts of heat stress on animal performance. Beede and Collier (1986) suggested three basic management options for reducing the effect of heat stress and these are (a) physical modification of the environment; (b) genetic development of less sensitive breeds and (c) improved nutritional management schemes.

Physical modification of the environment

- Prevention or reduction of solar radiation by providing shade and painting the roof white (Adin, 2010; Frank et al., 2005).
- Showering / wetting, ventilation, combination of showering and ventilation will help to cool dairy cows during heat stress.
- Fogging or misting, using fans or air conditioners will help cool cows during high temperatures. Sprinklers may also be used (Frank et al., 2005).
- Provision of cold water to cattle during hot days (Singh et al., 2012). Similarly, cows should be provided bedding and warmth to protect them from extreme cold. Other mitigation strategies include diversifying farming

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practices and changing planting dates (Singh et al., 2012). The use of heat tolerant crop varieties such as sorghum and millet is another mitigation strategy. As the rainy season is short and ends earlier (Simelton et al., 2011) early maturing plant/crop varieties could also be used as a mitigation strategy.

Improved nutritional management schemes

- Dairy feeding regime in Botswana should emphasize producing more fodder and less concentrates. Producing own feeds will be cost effective since 60-80% of production costs come from feeding (Madibela, 2013). Kalaugher et al. (2012) suggested that pasture production is the driving force in the New Zealand dairy system, resulting in small differences in pasture productivity reflecting proportionally larger differences in profit.
- Creating dairy belts in Botswana's traditionally arable producing areas such as Borolong in the south, the eastern side of the country and Pandamatenga farms in the north, which have relatively higher rainfall for fodder production (Madibela, 2013) appears to be appropriate. Crop residues produced from arable fields in these areas will provide a valuable feed resource for dairy animals.
- Conservation and storage of feed from the time of its availability to the time of its use could be a useful strategy of making feeds available to dairy animals during the dry season (Aganga et al., 2010b).

Genetic development of less sensitive breeds

Utilizing small frame dairy cattle such as Jersey and Brown Swiss which have higher volume/ weight index, making them easier to get rid of heat of metabolism (Madibela, 2013) appears to be a better option for Botswana. Smaller dairy breeds require less feed and do not suffer from heat stress as much as Friesian making them ideal for the local climate.

Lack of herd health programme and nutritional management skills are the major challenges in dairy production in Botswana. In order to raise the knowledge levels of farmers, Kumar (2012) suggested that there is a need for farmers to be equipped with management practices that are suitable to the conditions resulting from climate change.

CONCLUSION

Climate change affects livestock productivity in Botswana, especially the dairy sector which is currently performing poorly. There have been changes in rainfall patterns with rains coming late and inadequate amounts resulting in low crop yields and inadequate forages available for grazing. Unusually, high ambient temperatures occur requiring dairy cows to be provided with cow sheds in order to protect them from heat stress. Frequent droughts also call for farmers to grow fodder crops under irrigation, as well as, for harvesting and conservation of crop residues for later use. Furthermore, there is a need to consider using local *Tswana* cattle breed and smaller dairy breeds such as Jersey and Brown Swiss *in lieau* of Frisians which require large quantities of feeds and do not tolerate hot climatic conditions.

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OPTIMIZATION OF WHITELEG SHRIMP INTENSIVE PONDS PRODUCTION WITH DYNAMIC SYSTEM APPROACH OF LEMAH KEMBAR VILLAGE PROBOLINGGO EAST JAVA

SUCIYONO, S. ANDAYANI, M. MAHMUDI

Faculty of Fisheries and Marine Science Postgraduate Program, University of Brawijaya, Malang East java, Jl. Veteran 65145, Indonesia

*E-mail: suciyono@gmail.com

ORIGINAL ARTICLE

ABSTRACT: *The aims of this research was to assess the activities of that occur in ponds culture production intensive vanname shrimp in Lemah Kembar village, Sumberasih, Probolinggo regency, is based of production aspects. In this research, shrimp production was 4182.9 kg/plot, with a cultivation period of 98 days, the amount of 5621.5 kg of feed, with the results of analysis of aquaculture production as follows: Feed convention rate 1.34, Survival rate 75%, Specific growth rate 0,22 gram/days, Final weight 19.23 grams/individuals and 68% Feeding efficiency. The current research conducted a review on the process of intensive shrimp aquaculture production for 98 days, with a stocking density 102 individuals/m³ and evaluation of aquaculture production that occurs in the field. Based on optimization model which is applied, there are two options, the first is by partially harvest 45% (PR 2) so the harvest crop reached 4165.4 kg, total feed 5148 kg, FCR 1.24 with dissolved oxygen 0.4 ppm in the early days and 0.7 ppm in the end of the production. Second option is using non-partial model, harvest crop is 4,456 kg, total feed 5,862 kg, FCR was 1.21. It showed that the optimization model can increase production and significantly decrease FCR.*

Key words: *Pond Aquaculture, Whiteleg Shrimp, Optimazion Models*

INTRODUCTION

East Java is one of prominent contributors of Indonesian shrimp production. About 30% of national shrimp production, out of approximately 5 – 8 tons of national production from every harvesting time, is produced by some production centers in Sidoarjo, Pasuruan, Probolinggo, Situbondo and Banyuwangi (*Bisnis Indonesia,* December 7, 2012). Particularly in Probolinggo Regency, based on the data of Department of Maritime Affairs in 2011, there are 878.4 Ha intensive ponds to produce Giant tiger Shrimp from 1983 to 1995. In the early 2000s they stopped producing for five years because they fail to harvest due to bacterial and viral disease as a result of practical aquaculture which did not concern with the environmental support capability. Until now, there are approximately 223.10 Ha intensive ponds being developed to produce Whiteleg Shrimp (*Litopenaeus vannamei)*.

The problem with this intensive Whiteleg Shrimp aquaculture system is the mortality rate which is increasing with the decreasing pond water quality in the growing period. This decreasing water quality is caused by biomass activities like feces, uncontrolled feed and ammonia residue, which is possibly happened due to inappropriate/uncontrolled feed management. One indication of inappropriate feed can be seen by analyzing biomass ratio based on feed consumption ratio (FCR) and feed efficiency (FE). Significantly excessive feed amount will increase biomass ratio. It is said that 15% of the feed will dissolve and 20% of it is the primary contributor of biomass ratio (Primavera, 1994). Significant increase of biomass during the aquaculture will also increase the dissolved oxygen need in the water. Based on research of Boyd (2000), dissolved oxygen need for degradable process is 0.2 kg for a kilogram biomass. The high need of dissolved oxygen for the degradable process will affect biomass survival rate, which with significant increase of biomass will decrease the survival rate of the shrimps which also decrease the production. The solution to this problem is by analyzing feed supply efficiency (FCR improvement), so that production can be optimized with appropriate pond support capability and capacity.

Dynamic system is a metal concept, empirical relationship or collection of mathematical statements or can also be stated as simple representation from a complex system (natural system). For that reason, the model is an abstract illustration from a system where the variables are in the cause and effect relationship. The model can also be defined as a simplification of a system or a subsystem. The system is the illustration of a process or some well-regular processes. According to Jeffer (1978), a system can be seen so complex because of the processes involved, but the system is still a regularity.

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Based on the objectives, the simulation model can be divided into 3 (three) types: for process understanding, for prediction and for management need (Jeffer, 1978). The simulation model as a scientific method has some plus points, for example to support the definition and the classification of existing knowledge, to localize the gap in a certain field study and to explicitly make hypothesis in order to support in deciding the research priorities, as a mean to make standard operational information, as an effective cooperating medium among scientists of different discipline and scientific levels and also the model development as a sign of scientific advancement and accurate prediction improvement. A good model must illustrate the actual function of the system (Jeffer, 1978).

The model is a tool which can be used to support in illustrating the complex system conceptually and measuredly and even to predict the consequences of an activity which is if applied to the actual system will be very expensive and take long time or even damage the system itself. A good and correct model is the one which includes the essential part or an important functional component from the actual system. Modelling is necessary in order to understand the complex nature and its difficulties to be comprehended thoroughly. It means that modelling can be defined as a technique to conceptualize and measure a complex system or to predict the system response from human intervention.

The objective of this study is to analyze aquaculture production which consists of specific growth rate, survival rate, feed consumption ratio, feed efficiency and final weight so that total production and total feed can be measured and then we can analyze the optimization of the production with the dynamic approach. This research is expected to be able to create a complete model in optimizing production based on the existing aquaculture management, so that the model can be used to predict the expected optimization in the next aquaculture process.

MATERIALS AND METHODE

Material used in this research is an intensive pond, Whiteleg shrimp sample, the feed supply. The equipments used are digital weightscale, sampling net, daily feed log book and plastic bucket for biomass calculation. Method used is purpose sampling with quantitative approach, based on ex post facto (by following activities of the aquaculturist) so the known result is achieved by activities done for 4 months (from February to May 2013) in the intensive shrimp pond of Lemah Kembar village, Sumberasih subdistrict, Probolinggo regency, East Java.

Statistical analysis

Quantitative analysis approach: In production pond analysis, feed efficiency is the primary objective, because the success of the production depends on it. The most important factor in this matter is daily biomass estimation, absolute growth, growth rate and survival rate and the feed consumption rate to increase biomass weight (FCR), as shown in mathematical formula according to Cordova - Murueta, et al. (2003), as follows:

$Wt = W^o \times (1 + SGR/100)\ t$ .....

$SGR = \ln (W_t/W_0)/t \times 100$....

$JPt = Wt \times F$....

Discription:

Wt = Biomass in the day - t (g)

Wo= Biomass early (day - 0; g)

SGR= Specific growth rate (% / h)

JPt= The number of days to feed on - t (g)

Ep = efficiency of feed

F = Percentage of feeding (%)

t = Rearing periode

And then according to Haetami in 2012 feed efficiency ratio is the percentage of well-digested feed, whch is then transformed and added the shrimp weight. To measure the feed efficiency formula used is:

$Ep = GA/F \times 100\%$

Description:

Ep = Efficiency of feeding (%)

GA = Growth absolute (g)

F = The amount of feed given (g)

According to Smith *et al*., (2002), to know the amount of feed used to add the shrimp weight use FCR and shrimp weight addition by using this formula:

$AFI = FCR \times WT_w$

Description:

AFI = Feed given for a specific period (kg)

FCR = feed conversion ratio

WT_w = weight of added biomass (kg)

Dynamic system approach: Model development is done by using dynamic system approach. This method can reinforce our inquiry skill in the complex system (Sterman, 2000). To model the dynamic system issues, tools *Vensim, Stella, Powersim*, and other simulation software are needed. For that reason, *Stella 9.1.4* software is used in this research.

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Model development starts with system conceptualization which is done by making conceptual model which is illustrated by causal loop diagram. System conceptualization is used to illustrate generally the simulation of dynamic system being done. The conceptual model is then translated into dynamic system model through stock and flow maps. Formulation on the model is done by understanding and testing the model consistency whether it is appropriate with its objective and limitation. After the model is made, then verification phase is carried out. In this phase, the model is checked whether it is appropriate, sensible and there is a consistent formulation or the measuring unit. Then the system model is simulated and the result then is validated to ensure that the model can represent the actual system. Dynamic system analysis is conducted to optimize the production of Whiteleg shrimp culture, in accordance with the achieved data based on quantitative analysis with the concept of Grant et al. (1997), Sterman (2000), as follows:

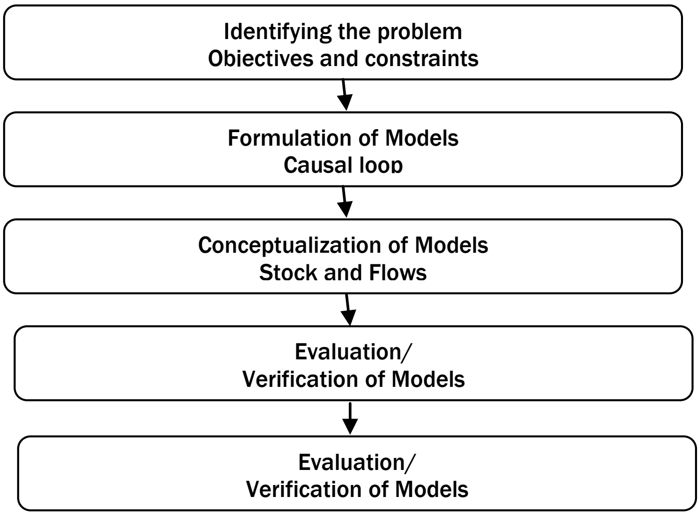

Figure 1. Framework of System Modeling Operational Phases; (Source: Grant et al., 1997; Sterman, 2000).

Figure 2. Pond Aquaculture Spatial Location. (Source: Results of the data if the GIS Image 2013)

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DISCUSSION

Research Pond Area Condition

Geographically Lemah Kembar village is in the coordinates of 7° 40' to 8° 10' S dan 112° 50' to 113° 30' E. Administrative line of Sumberasih subdistrict ends on Madura strait in the north. In the east it is adjacent to Probolinggo subdistrict, in the south is adjacent to Wonomerto subdistrict and in the west with Tongas subdistrict with total area of 30,25 km^2. (Statistics Indonesia Probolingggo Regency, 2011). The lay out of the culture pond is positioned in the traditional aquaculture and farming area, and this pond was actually a part of traditional ponds which method is changed to intensive aquaculture since 2010. The construction of the culture pond is using cast concrete for the side but not for the pond base. Every pond uses six watermills as the oxygen suppliers, four feed sampling and shrimp growth cross nets, with outlet system in the central drain and the effluent is directed to the waste drainage as seen in Figure 2.

Culture Production Analysis

Culture production analysis is the total shrimp biomass in the harvesting time. Some parameters supporting production are initial biomass average weight, culture's length period, feed amount, seed number, etc. Based on the quantitative calculation, specific growth rate (SGR), survival rate percentage (SR), absolute growth rate (GR), feed consumption ratio (FCR) and feed efficiency (Ep%).

Table 1 - Vannamei shrimp aquaculture production for 98 days

Parameters	Value
Number of initial biomass (Individual)	362400
Extensive ponds (m^2)	3200
Number of final biomass (individual)	244.929
Initial weight biomass (gram/individual)	0.005 - 0.007
Final weight biomass (gram/individual)	19.23
Rearing periode of aquaculture (day)	98
Total of feed (kg)	5621.5
Total of harvest (kg)	4182.79

Sources: Data analysis of aquaculture production in 2013

Survival Rate: Based on quantitative analysis which is done by counting initial shrimps (No): 326.400 shrimps and the total number of shrimps in the end (Nt): 224.929 shrimps, we achieve final SR in the percentage of 75% for the 98 days of Whiteleg shrimp culture with approximate density about 102 /m^2. Widiasa (2005) reported culture result of Whiteleg shrimp in Barru regency with density of 57/m^2, length period of 100 –105 days, the harvest shrimps were 17.5–19.2 g for each individual shrimp with survival rate about 81– 87 % and the production reached 2.9 – 3.2 tons/3.500 m^2.

Specific Growth Rate: The observation on the specific growth rate for 98 days of culture period showed significant improvement along with the increase of feed and the culture period, in the beginning of the culture Day 1 – Day 49 the weight reached 0.167 g for each individual shrimp, Day 49 – Day 60 is 0.324 g for each individual shrimp, then Day 60 – Day 72 is 0.245 g for each individual shrimp. The weight on Day 73 – Day 81 is 0.158 g for each individual shrimp, on Day 82 - Day 90 is 0.192 g for each individual shrimp, on Day 90 – Day 98 is 0.152 g for each individual shrimp. The highest growth rate is on Day 49 – Day 60, followed by growth on Day 60 - Day 72, and it decreased significantly along with the length period, even though there is an increased growth on Day 81 – Day 90 due to density declining at the age of 72 days. The average specific growth rate in this research is about 0.20 ∂ 0.061 g for each individual shrimp.

Growth Rate: Average of total growth rate is 18.87 ε 0.503 g for each individual shrimp (size 54 – 52), quantitative analysis result by measuring final weight (W_t) and growth early (W_o) of Whiteleg shrimp, resulted final weight about 19.02 gram for each individual shrimp with total production 4182.79 kg/3200m^2. Final weight for each individual shrimp is 19.23 gram, as shown in Figure 3.

Final individual weight of Whiteleg shrimp achieved in this research is bigger than the research by Haliman and Adijaya in 2005, which reported about Whiteleg shrimp culture in Situbondo, East Java with 150 shrimps/m^2 density, 85 % of survival rate, final weight of 14.28 g for each individual shrimp, produced 5.465 kg/3000 m^2 with 1.5 FCR. This agreed with Sugama statement (2002) that some aquaculturists succeed in culturing Whiteleg shrimp with production result ranged from 6 – 12 tons/ha, 65 – 85% of survival rate, 1.0 – 1.2 FCR in a culture period of 100 – 110 days, and the harvested shrimps were about 12.5 – 17.0 g for each individual shrimp (size 60 – 80).

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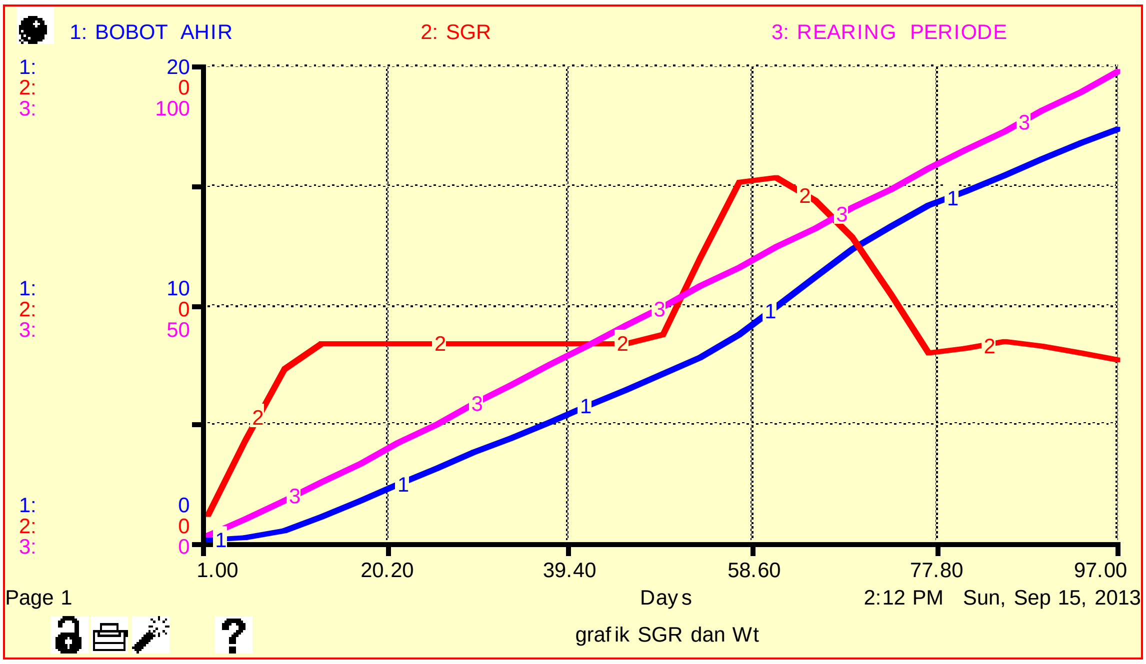

Figure 3 - Specific growth rate graphic vanname shrimp. (Source: analysis of production data @ stella 9.1.4)

Food Convention Rate: Based on the data in Table 1 Food Convention Rate or the amount of feed in kilograms which is need to produce 1 kilogram biomass/shrimp, in this research, the result achieved is 1.34 kg feed is needed to produce 1 kg of shrimps with regression equation Y=1254.65+0.532X+e with determination coefficient R^2= 0,98. Biomass increase fluctuation is significant with the feed increase in the beginning of the production until Day 72, but it decreased relatively in the end of the culture and the harvesting time in line with the decreasing growth rate and feed as shown in Figure 4.

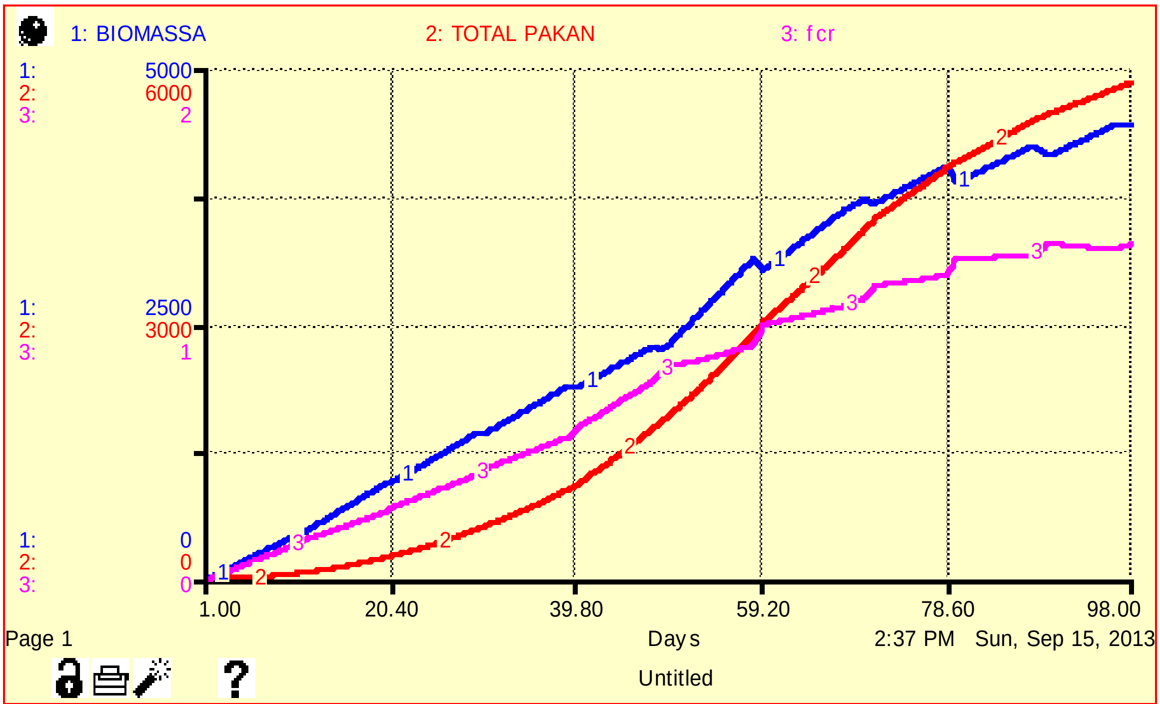

Figure 4 - Relationship graph of feed utilization and weight of shrimp during cultivation @ stella 9.1.4

Feed percentage in this research is higher in comparison with the anonymous research in 2003 which resulted 1.3 FCR for Whiteleg shrimp culture with 90 shrimps/m² for 110 days, but is lower than Trenggono's research which with the same length of period and density had achieved 1.4 FCR. Haliman and Adijaya (2005) reported about Whiteleg shrimp culture in Situbondo, East Java with 150 shrimps/m² density, 85 % survival rate, 14.28 gram final weight for a shrimp and produced 5,465 kg shrimps/3000m² with 1.5 FCR.

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Feed Efficiency: According to Haetami (2012), feed efficiency is the percentage of well-digested feed which is then add the weight of an individual shrimp. Quantitative analysis result conducted in this research by calculating absolute growth (GA) with the feed given (F) in grams, achieved 14.70 gram for each individual shrimp and need 17.49 g for each individual shrimp so that Ep (feed efficiency) got is 84% at the age of 72 days, then the feed efficiency kept decreasing until harvesting time with details as follows: on Day 81 the Ep is 46%, on Day 90 and Day 98 the Ep is 52% and if accumulated the Ep is 68%. The result was caused by excessive feeding in the final period of culture, which caused by inappropriate biomass sampling management with the survival rate of 78% at the age of 72 days, and with mortality rate of 7% after 72 days until harvesting time (98 days). Based on (Primavera and Apud research, in 2004), 85% digested feed is used for growth for about 80%, 20% in the form of feces and the 15% dissolves in the water.

Optimization of Culture Production

Causal loop: Causal loop diagram is an illustration of causal relationship among variables interacting in the system. Causal loop diagram is arranged based on its causal relationship among variables from the production Whiteleg shrimp in intensive pond in Lemah Kembar village, Sumber asih, Probolinggo. Causal loop diagram is developed by adding causal relationship among variables which affect the culture production. For example, daily feed increase is in line with biomass weight increase but they are inversely proportional to the survival rate. The causal loop diagram then illustrates the interaction of production variables, feed supply and biomass is related by arrow and plus symbols, but arrow and minus symbols illustrate the survival rate.

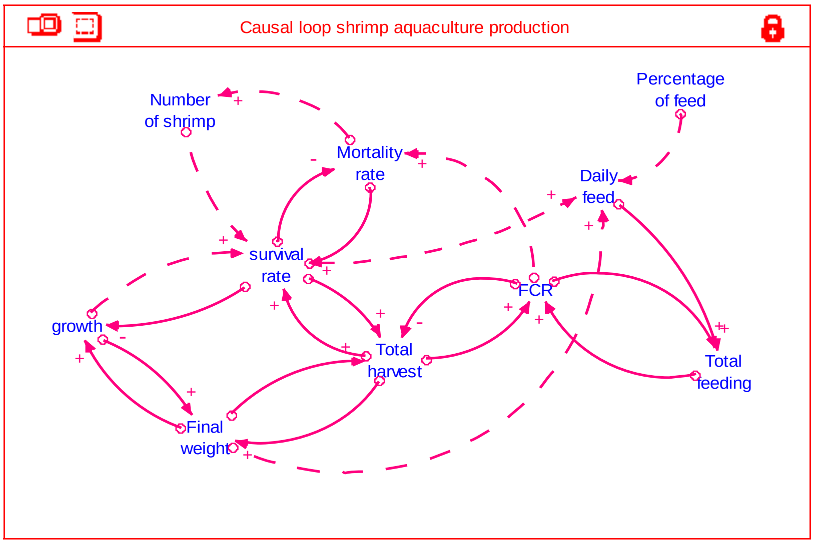

Figure 5 - Causal loop diagrams of shrimp vanname production

Conceptualization (*stock and flow*): Stock and flow maps are made based on causal loop diagram arranged. Stock and flow maps model of this research is divided into to sub models. This model development also involves mathematical formulation. This formulation shows the relation among the interacting variables, both concept arranged is based on the actual condition as shown in Figure 6 as follows:

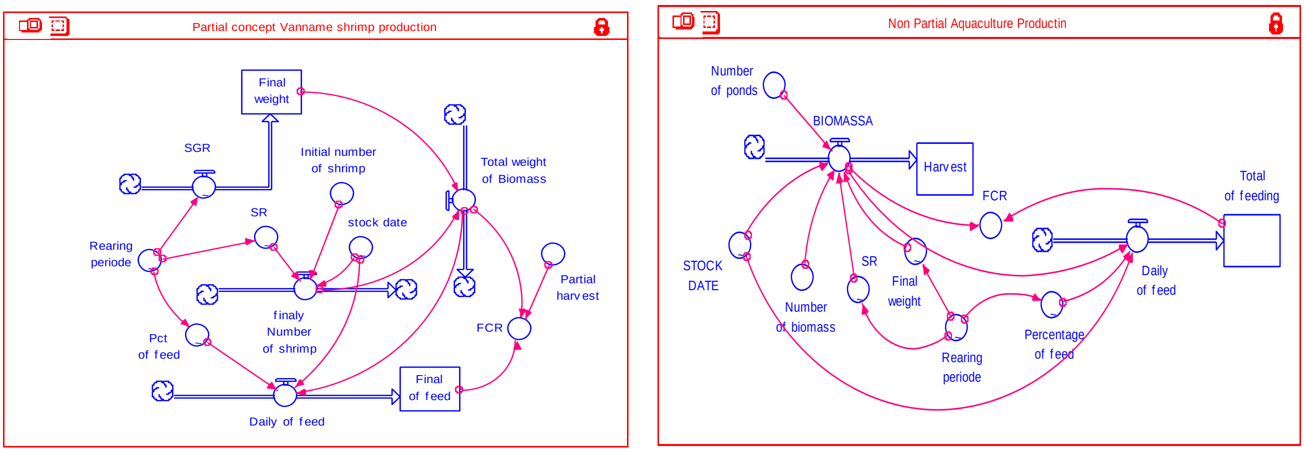

Figure 6. Conceptual models partial and non - partial

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Verification: Verification phase is a phase where simulation model is checked whether it works in logical way on the system object, whether it is appropriate with the conceptual model which is made. Checking process is conducted by check units and verification with STELLA software. The check units work to ensure the measurement consistency is appropriate with the formulation made. While verification is done to check formulation in the model and error which can be done by the made model.

Simulation Result:

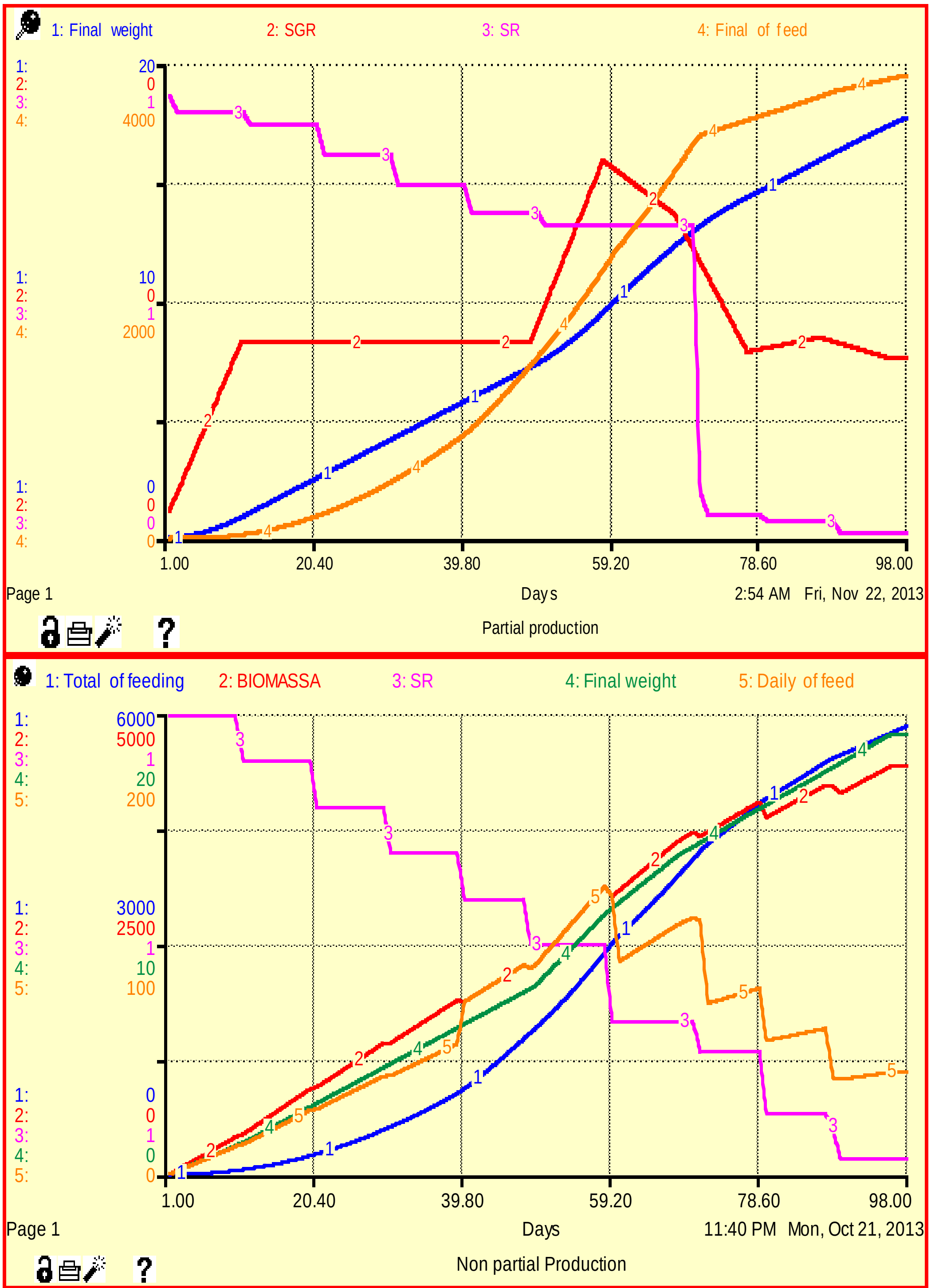

Figure 7. The simulation models partial and non-partial

Validation: Validation phase is a phase to ensure whether the made model can represent the actual observation object condition. Model validation process is conducted by discussing with the experts to ensure that the model which is made is correct and appropriate with the actual and existing system.

Model Discussion

Biomass shrimp production with dispersion of 326,000 shrimp/pond is 4182 kg with 68% SR, simulation result showed productivity about 3233 kg with 61% SR. In the existing pond, final biomass weight is 19.23 g for each individual shrimp while the simulation result is 17.82 g for each individual shrimp, with another words, total growth rate is 7% decreasing from the existing growth, this is in line with the total feed decrease which affect on the existing FCR improvement, which is about 1.34 in the existing pond and 1.24 in the simulation result. If non - partial culture production is done with the seed number, feed dosage and the culture period is same with the actual condition existing on the field, then harvest crop will be about 4,456 kg, feed supply is 5,862 kg, simulation final weight (Wt) is 19.23 g for each individual shrimp, final SR is 71%, FCR is 1.31 with average daily feed is 0.4% of biomass weight.

CONCLUSION

1. Intensive pond culture production result in this research showed $FCR_{initial}$ was 1.18 with 4,453 kg feed, biomass weight was 3,744 kg, in the period of 72 days and 78% SR with final weight was 14.7 gram for each individual shrimp (Size 68) harvested crop reached 1,714 kg. Then in the end of the culture showed FCR_{final} 2.1, with 1.118 kg feed and harvested crop was 2468,79 kg, 93% SR at the age of 98 days with Wt 19.23 gram. Overall production resulted FCR 1.34 with total harvested crop was 4182,79 kg with total feed 5621.5 kg, *stocking density* ±102 shrimps/m^2, the total survival rate (SR_{total}) was 75%, with final weight 19.23 grams for each individual shrimp (size 52) and specific growth rate of 0.22 ∂ 0.063 or achieved growth rate of 18.87 ε 0.503 gram/individual shrimp (size 54 – 52) then the feed efficiency in this culture production cycle was 68%.

2. Based on optimization model which is applied, there are two options, the first is by partially harvest 45% (PR 2) so the harvest crop reached 4165.4 kg, total feed 5148 kg, FCR 1.24 with dissolved oxygen 0.4 ppm in the early days and 0.7 ppm in the end of the production. Second option is using non-partial model, harvest crop is 4,456 kg, total feed 5,862 kg, FCR was 1.21. It showed that the optimization model can increase production and significantly decrease FCR.

Suggestions

1. It is necessary to do the growth sampling thoroughly in the culture which is done, so that high production efficiency can be achieved in the ecology and the economy, which is in linear will affect to the pond quality improvement.

2. Shrimp culture production evaluation is expected based on the model which is made in accordance with culture management in the existing condition to validate model which is used.

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ORIGINAL ARTICLE

EFFECTS OF NATIVE AND MICROBIAL PHYTASE ON LAYING PERFORMANCE, SHELL ASH AND PHOSPHORUS CONTENT OF HENS FED MASH AND PELLETED DIETS

S.G. Ademola[1]*, T.E. Lawal[2], O. Odu[3], M.D. Shittu[4], H.O. Oladiran[1] and M.T. Adeshina[1]

[1]*Department of Animal Nutrition and Biotechnology, LAUTECH, Ogbomoso, Nigeria*
[2]*Department of Animal Science and Fisheries Management, Bowen University, Iwo, Nigeria*
[3]*Department of Animal Science Univ. of Ibadan, Ibadan, Nigeria*
[4]*Department of Animal Production and Health, LAUTECH Ogbomoso, Nigeria*

*E-mail: ademolasadiq@yahoo.com

ABSTRACT: *The study investigated effects of microbial phytase and native wheat bran phytase on laying performance, egg quality and shell phosphorus of hens fed two forms of diets. Five experimental diets were formulated for the study. Control and basal diets contained similar levels of nutrients. However, basal diet (T1) containing 15% wheat bran (WB) had lower available phosphorus (AVP). Diet forms (mash and pelleted) and microbial phytase supplementation (0 and 900 phytase unit (FYT) were arranged to examine their interaction effects. The 0 FYT microbial phytase represented the native wheat bran phytase activity in the mash diet only. T1 and T2 were mash and pelleted unsupplemented diets respectively. Diets in T3 and T4 were microbial phytase supplemented in mash and pelleted forms respectively. Laying hens fed unsupplemented mash basal diet (T1) had the highest hen day production (HDP) (P<0.024), and the best feed conversion (P<0.012). However, those fed mash supplemented diet (T3) had the lowest HDP and worst feed conversion. Microbial phytase supplementation to mash diet (T3) resulted in lowest egg mass of 45.35 gram daily (P<0.025). Pelleting the unsupplemented diet (T2) yielded poorer feed conversion than those fed unsuplemented mash diet (T1). Hens fed pelleted supplemented diet (T4) had slightly reduced HDP and significantly lower egg mass when compared to the control group. These hens had significantly highest yolk index (P<0.036) and egg shell with the most concentrated phosphorus content (P<0.002). It is concluded that native wheat bran phytase in mash diet containing 15% WB was effective for improved laying performance.*

Key words: *Hen Day Production, Microbial, Native Phytase Wheat Bran*

INTRODUCTION

Phytic acid is a major component of all plant seeds constituting 1-3 percent by weight of many cereals and oil seeds and typically accounting for 60 to 90 percent of the total phosphorus (Graf, 1983).The acid impedes the utilization of a number of important inorganic and organic compounds such as phosphorus, divalent cations and proteins as a result of insufficient endogenous phytase secretion by poultry. The poor digestive utilization of phytate phosphorus by laying hens and its consequences on diet cost, environment and, bioavailability of mineral and protein have led to efforts directed towards improving phytate digestion (Dilger et al., 2004). Strategies to overcome the poor utilization of phytate phosphorus by poultry include addition of expensive inorganic phosphorus, and microbial phytase preparation. Phytases have been identified in plants, micro-organisms and in some animal tissues (Konietzny and Greiner, 2002). Eeckhout and de Paepe (1994) reported that some feedstuffs contain 6-phytase activities (wheat, wheat bran, rye and barley) whereas others have little or no phytase activity (corn, oat, sorghum and oilseeds). Wheat bran has some phytase activity and it could be used as a viable source of phytase (Muhannad, 2010). Steiner et al. (2007) found that wheat bran contained 6-phytase activities ranging between 2349 and 9945 U/Kg.

Several authors have documented effects of heat treatment on pelleting native phytase from plant sources. Cavalcanti and Behnke (2004) reported that phytase activity may considerably reduce when wheat bran (WB) is processed into pellets because heat treatments destroy phytase. Also Hattingh (2002) asserted that some feed ingredients contained native phytase activity and that steam pelleting used in manufacture of many commercial poultry feeds resulted in significant losses of this intrinsic phytase activity. The limitation of most commercially available phytases was the inactivation of their activities when pelleted at a temperature greater than 70^{0}C (Jongbloed and Kemme, 1990). Moreover, variation in phytase activities among and within plant species with

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damaging effect of pelleting during feed manufacturing and the lack of availability of feed ingredients of high phytase activity, the presence of residual phytase activity often may not be considered in diet formulation when feed are pelleted (Kornegay, 1999). Varying responses have been reported on the effect of pelleting of feeds in relation to the availability of phosphorus from phytate. Pelleting of feed at 81^{0}C reduced the phytin content in a mixed rape seed, barley and pea diet by 7% (Skoglund et al., 1997). Improved utilization of the phytate phosphorus from a corn-soybean diet containing 25% wheat bran as a result of steam pelleting has been reported (Summers et al., 1967). However, reduction of phosphorus availability by pelleting of feeds containing phytase activity from wheat was observed by Jongbloed and Kemme (1990). Steam pelleting also failed to enhance phytate phosphorus availability from a corn-soybean diet when fed to laying hens (Pepper et al., 1969).The presence of high phytase activity in wheat bran and the inconsistency in responses of animals fed pelleted diets in relation to phosphorus availability stimulated the current investigation. Hence, the study assessed effects of microbial phytase preparation and native wheat bran phytase on laying performance, egg quality and egg phosphorus content of hens fed mash and pelleted corn-soybean meal-wheat bran-based diet.

MATERIALS AND METHODS

Site of the experiment

The study was carried out in Layer House of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. A period of 8 weeks was observed for the experiment.

Information on the commercial phytase product

The phytase enzyme used in this study was Ronozyme® NP (CT). The active agent of Ronozyme® NP is 6-phytase, produced by a strain of *Aspergillus oryzae*. One phytase (FYT) unit of Ronozyme® NP is defined as the amount of enzyme that liberates one µmol of inorganic phosphate from sodium phytate per minute at pH 5.5 and 37^{0}C (von Holst, 2008). Wheat bran was the major source of native phytase activity in the basal diet and active only in mash diets. This is because heat treatment destroys native phytase of wheat bran in the pelleted basal diets.

Formulation of experimental diets

Five experimental diets were formulated for the study. Control diet (mash form) contained adequate levels of metabolizable energy, crude protein, calcium and available phosphorus. Control diet did not contain wheat bran. Basal diet contained15% wheat bran and the available phosphorus was however lowered by 0.16% when compared to control. A 2X2 factorial arrangement for form of basal diet (mash and pelleted) and microbial phytase supplementation (0, and 900 FYT/Kg) was used to examine interaction effects on measured parameters. Wheat bran was the major source of native phytase to mash basal diet which was represented by 0 FYT microbial phytase. Two basal diets in T1 and T3 were in mash form, and the other two diets (T2 and T4) were in pelleted form. A commercial microbial phytase preparation [Ronozyme® NP (M)] was supplemented in diets T3 and T4 while this phytase preparation was not added to diets in T1 and T2. Thus, two groups (T1 and T3) represented diets with native wheat bran phytase, but diet in T3 also contained supplemental microbial phytase preparation (Table 1). Pelleting of the diets (T2 and T4) was done at a temperature of 65^{0}C.

Table 1 - Ingredients composition of experimental diets

Parameters	Control	T1 (Mash)	T2 (Pellet)	T3 (Mash)	T4 (Pellet)
Corn	42.00	52.00	52.00	52.00	52.00
Soybean meal	20.90	20.90	20.90	20.90	20.90
Corn bran	24.65	-	-	-	-
Wheat bran	-	15.00	15.00	15.00	15.00
Fish meal (72%CP)	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	1.00	1.00	1.00	1.00
Oyster shell	6.85	8.50	8.50	8.50	8.50
Methionine	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin Premix*	0.25	0.25	0.25	0.25	0.25
Ronozyme NP (M)	-	-	-	+	+
Analysed composition					
Crude protein (%)	16.30	16.50	16.50	16.50	16.50
Crude fibre (%)	5.15	3.70	3.70	3.70	3.70
Calculated analysis					
Energy (Kcal ME/Kg)	2680.03	2687.68	2687.68	2687.68	2687.68
Methionine (%)	0.38	0.39	0.39	0.39	0.39
Lysine (%)	0.84	0.97	0.97	0.97	0.97
Available P (%)	0.58	0.42	0.42	0.42	0.42
Calcium (%)	3.68	3.54	3.54	3.54	3.54

*The following vitamins and trace elements were supplied per kg of the layer diet: 10,000IU Vit. A; 2,00IUVit. D_3; 23mg Vit K_3; 3mg Vit. B_1; 6mg Vit. B_2; 50mg Niacin; 10mg Calcium Pantothenate; 5mg Vit B_{12}; 1mg Folic Acid; 0.05mg Biotin; 400mg Choline Chloride; 120mg Mn; 100mg Fe; 80mg Zn; 8.5mg Cu; 1.5 I; 0.3mg Co; 0.12mg Se and 120mg Antioxidant.
+ Ronozyme NP supplied 900 FYT phytase to the basal diet at 18mg/kg

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Management of experimental laying hens

A total of 160 Nera Black laying hens (25 weeks old) were distributed to five experimental groups in a completely randomised design (CRD). The laying hens were kept in battery cage system. There were 4 replicates of 32 hens per treatment group. These birds were fed experimental diets *ad libitum* and clean water was also supplied to them. Vaccination and medication were carried out as at when necessary.

Data collection

Egg production was monitored on daily basis and number of eggs collected for each replicate was used in calculation for hen day production. Egg weight was estimated with the aid of a sensitive weighing scale. Feed intake and feed conversion were also determined on a replicate basis. A total of 240 eggs with 12 eggs per treatment selected each week for 4 weeks for egg quality assessment. Yolk index was expressed as a ratio of yolk length and yolk height.

Chemical analysis

Crude protein and crude fibre of the experimental diets were carried out using the methods of AOAC (2000). Broken egg shells were rinsed in water, air dried and ground with pestle and mortal. Eight shell samples per treatment were digested by dry ash-procedure at 600^{0}C for 6 hours to estimate eggshell ash. Furthermore, 8 egg shell samples per treatment were digested by wet-ash procedure using perchloric acid and nitric acid. Phosphorus concentration was determined colorimetrically (Genesys 5 Spectrophotmer; Thermo Electron Corporation, Madison, WI) at 410nm according to AOAC (1995) methods.

Statistical analysis

All data collected were analyzed by factorial analysis under CRD using SAS (1999). Significant means were separated using Duncan option of the same statistical software. A probability of 5 percent was considered significant ($P<0.05$).

RESULTS

Table 2 displayed laying performance and egg quality of hens fed either mash or pelleted basal diet containing 15% wheat bran with or without phytase supplementation. Dietary treatment significantly affected hen day production (HDP), egg mass, feed conversion and yolk index. Laying hens fed unsupplemented mash basal diet with native phytase activity from wheat bran (T1) had the best HDP ($P<0.024$) and significantly ($P<0.012$) improved feed conversion when compared to those fed other basal diets. Microbial phytase supplementation to mash basal diet (T3) caused significant reduction in HDP and pelleting basal diet with supplemental microbial phytase (T4) slightly reduced HDP. Laying hens fed unsupplemented pelleted diet (T2) had the heaviest egg mass which was comparable with those unsupplemented mash basal diet (T1) and control diet. Microbial phytase supplementation to mash and pelleted basal diets (T3 and T4) significantly reduced the egg mass when compared to others. Interaction effect of diet form and phytase supplementation significantly influenced the yolk weight ($P<0.047$) and albumen weight ($P<0.024$) with hens fed unsupplemented mash basal diet (T1) laid heavier egg yolks and lower albumen when compared to those fed other basal diets. Laying hens fed pelleted basal diet supplemented with microbial phytase (T4) had significantly higher yolk index and improved egg shell phosphorus content when compared to those fed other diets.

Table 2 - Laying performance and egg quality of laying hens fed mash and pelleted diets containing native wheat bran- and microbial- phytase

Parameters	Control	T1 (Mash)	T2 (Pellet)	T3 Phyt (Mash)	T4 Phyt (Pellet)	P-value	SEM	Diet Form	Phyt	Int.
HDP (%)	84.52[a]	86.09[a]	84.81[a]	80.69[b]	83.19[ab]	0.024	1.05	0.518	0.002	0.062
Egg weight (g)	56.72	55.39	56.79	56.22	54.95	0.147	0.58	0.918	0.431	0.053
Egg mass (g/day)	47.92[a]	47.68[ab]	48.18[a]	45.35[c]	45.70[bc]	0.025	0.68	0.565	0.006	0.924
Feed intake (g/bird/day)	108.41	104.61	108.63	108.48	110.57	0.233	1.73	0.115	0.132	0.600
Feed conversion ratio (feed/egg)	2.27[b]	2.23[b]	2.43[a]	2.44[a]	2.43[a]	0.012	0.05	0.053	0.035	0.043
Yolk weight (%)	24.25	24.03	22.17	22.47	23.52	0.373	0.88	0.561	0.882	0.047
Albumen weight (%)	64.66	63.13	66.09	66.09	64.85	0.268	3.12	0.329	0.325	0.024
Shell weight (%)	11.09	12.93	11.65	11.44	11.63	0.115	0.60	0.321	0.173	0.159
Yolk index	0.43[b]	0.46[b]	0.43[b]	0.43[b]	0.62[a]	0.036	0.05	0.131	0.138	0.059
Shell P (mg/100g)	0.41[b]	0.45[b]	0.50[b]	0.47[b]	0.73[a]	0.002	0.06	0.010	0.030	0.069
Egg ash (%)	51.00	52.00	53.00	54.00	50.00	0.201	1.21	0.279	0.712	0.083

Means along the same row with different superscripts are significantly different ($P<0.05$). Phyt=phytase supplementation

DISCUSSION

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Monogastric organisms contained no or only negligible amount of endogenous phytase in the stomach and small intestine, these animals are therefore dependent on plant or microbial phytase (Pallauf and Rimbak, 1997).The positive response for laying hens fed unsupplemented mash basal diet containing 15% wheat bran revealed that native phytase from plant source could not be totally neglected if the diet was in mash form. It has been reported that hydrolysis of phytate within the digestive tract of poultry may be attributed to the action of phytase from one of three possible sources namely plant feed ingredients, animal-intrinsic phytase activities and microbial origin (commercial) phytase product (Ravindran et al., 1995). However, pelleting the basal diet adversely affected the potency of the native wheat bran phytase as the feed conversion of laying hens fed unsupplemented pelleted basal diet (T2) was poorer when compared to those fed unsupplemented mash basal diet (T1). Inactivation of the wheat bran phytase may be reason for the poor feed conversion. This finding is in consonance with the report of Cavalcanti and Behnke (2004) that heat treatment destroys phytase. Ullah and Mullaney (1996) also stated that losses in activity of phytase enzyme begin to occur when feeds are subjected to steam pelleting around 60^{0}C.

Phosphorus content in egg shell of control hens was not significantly different from those fed basal diets except those fed pelleted basal diet supplemented with microbial phytase (T4). This showed that lowering available phosphorus in layer diet from 0.58% to 0.42% did not compromise the availability of phosphorus for egg shell formation for hens fed basal diets containing wheat bran. Phosphorus was most concentrated in egg shell of hens fed microbial phytase pelleted diet. This observation corroborated with the finding of Summers et al. (1967) who observed improved utilization of the phytate phosphorus from a corn-soybean diet containing 25% wheat bran, as a result of steam pelleting.

The impact of phytase activity from wheat bran on utilization of phytate phosphorus and performance of poultry has been documented by several authors. Wheat bran's phytase may improve the absorption of phosphorus from cereals when given to simple stomach animals (Lesson and Summers, 2005). Yao et al. (2007) reported that ten percent of wheat bran replacing 0.05% inorganic phosphate did not influence either egg yield or nutrient utilization. These authors concluded that wheat bran phytase improved the performance and the utilization of dietary total phosphorus and crude protein of laying hens. The present study revealed that 15% wheat bran (with the intrinsic phytase activity) in unsupplemented mash layer diet achieved similar hen day production and egg mass with those of the control group, despite lowering available phosphorus by 0.16%. The improved laying performance of hens fed mash basal diet containing native wheat bran was in agreement with the conclusion of Cavalcanti and Behenke (2004) that wheat bran phytase improved plant phosphorus utilization and increased growth rate of broiler. Addition of microbial phytase preparation to mash basal diet (T3) did not further increase the laying performance of hens but it resulted in poorer feed conversion. Some authors have demonstrated that wheat bran or wheat bran (50%) supplemented with enzyme preparations have positive effect on the performance of broilers and laying hens (Abaza et al., 2004 and Ali et al., 2006). Higher dietary concentration of wheat bran may probably be the reason for the varying response observed in laying performance between the findings of these authors (Abaza et al., 2004 and Ali et al., 2006) and the present study.

In conclusion, native wheat bran phytase activity in the mash basal diet was effective to achieve maximum laying performance of hens but microbial phytase supplementation to the mash basal diet yielded poor feed conversion. Furthermore, pelleting of corn soybean meal diet containing 15% wheat bran adversely affected feed conversion of the hens. Phosphorus was more concentrated in the egg shell of hens fed pelleted diet supplemented with microbial phytase.

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GROWTH PERFORMANCE EVALUATION OF JUVENILES OF *Archachatina marginata* OVUM AND *Archachatina marginata saturalis* SNAIL SUBSPECIES FED FORAGES AND THEIR NUTRIENT COMPOSITION IN CROSS RIVER RAINFOREST ZONE, NIGERIA

J. A. UBUA[1], E. A. AGIANG[2], P. O. OZUNG[2] and V. N.EBEGBULEM[2]

[1] *Department of Animal Science, Taraba State University, Jalingo, Nigeria*
[2] *Department of Animal Science, University of Calabar, Calabar, Nigeria*

*E-mail: pascalozung@yahoo.com

ABSTRACT: *The growth performance characteristics of juveniles of Archachatina marginata ovum and Archachatina marginata saturalis snail subspecies were evaluated using a feeding regime of forages. The forages of choice utilized were: Sweet potato (T_1), Cocoyam (T_2), Banana (T_3), pawpaw (T_4) and Okra (T_5) respectively. The nutrient composition of these forages was equally determined. Results from this study revealed that juveniles of Archachatina marginata ovum recorded better feed intake than those of Archachatina marginata saturalis. The weight gain showed significant difference (P<0.05) between juveniles of the two subspecies. Results of the feed conversion ratio (FCR) were also significantly different (P<0.05) between the subspecies. Treatment 1 (Sweet potato leaves) recorded overall best result in terms of performance compared to other forages used in this study. Results of proximate composition of forages showed that Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether Extract (EE), Nitrogen Free Extract (NFE) and Ash ranged from 75.16 - 79.62%, 10.88 - 12.76%, 14.45 - 19.68%, 16.82 – 69.00%, 31.10 - 32.63% and12.63 - 17.94% respectively. Okra leaves had the highest Dry matter and Ash contents which were significantly different (P<0.05) from other forages. Sweet potato leaves recorded the least Dry matter and Ash contents and the highest Crude protein content while Okra leaves had the least. However, values of CP in sweet potato leaves were significantly different (P<0.05) from Cocoyam and Okra leaves. The EE content in all the forages were relatively low but sweet potato recorded the highest and Okra the least. There was no significant difference (P>0.05) in Ether extract among the forages. Result of CF showed relative increase across the five forages. Banana leaves had the highest value and was significantly different (P<0.05) from those of sweet Potato and pawpaw leaves. The highest NFE content was recorded in sweet potato leaves. There was significant difference (P<0.05) in the Ash content among all the forages except sweet potato. Results from this study were within the normal proximate values of these forages and confirmed that these leaves (plant protein sources) are good forages for farm animals especially micro-livestock like snails and can enhanced optimum growth characteristics.*

ORIGINAL ARTICLE

Key words: *Growth Performance, Juvenile Snails, Nutrient, Composition, Forages*

INTRODUCTION

In Nigeria as well as other developing nations of the world, the problem of protein deficiency in human diets is a common phenomenon. The geometric rise in human population is in conflict with the arithmetic growth of the livestock subsector. Snail captivity is attracting the keen interest of scientists and farmers suggesting the potentials of these species for commercial farming in humid tropics (Ubua et al., 2012). The population explosion implies that many people require the supply of adequate protein in their diets because of the important roles it play in human wellbeing which include growth, maintenance of hormonal and enzymatic activities as well as improvement of the defence mechanism of the body (Ademolu et al., 2004). The survival, growth, development and reproduction of snails like that of other animal species depend largely on the quality of feed consumed. Thompson and Cheney (2004) identified various factors that could greatly influence the survival and growth of snails. These factors include husbandry, population density, stress, and temperature, feed and breeding technology used. Most of the conventional protein sources like beef, pork, poultry and rabbit meat are presently too expensive for the common man. The advent of heliculture (Snail farming) will go a long way in bridging the protein inadequacy gap faced by Nigerians.

According to Ebenebe (2000), the problem of animal protein intake in Nigeria can be ameliorated if there is integration into our farming system some non-conventional meat sources to complement the conventional animal sources. The challenge lies on the micro-livestock sub-sector in which the snail is one of such micro-livestock species (Nodu and Adesope, 2002). Edible African giant land snail is a small animal commonly classified as mini-

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livestock and unduly distributed all over the humid tropical zone of Africa (Ibom et al., 2008). The snail has been reported to constitute an important source of animal protein for many local communities in Nigeria (Fagbuara et al., 2006). Omole (1997) stated that the Africa giant snail (*Archachatina marginata)* (Swainson) is the most common edible land snail found and reared in Nigeria. Ogogo (2004) recognized *Archachatina marginata* as the most common breed in Cross River and Akwa Ibom States of Nigeria. Snails have high rate of productivity and attains sexual maturity at about 4-6 months (Akintomide, 2004). Snails are herbivores and are known to feed on a wide range of plants, especially wild and cultivated species of Angiosperm (Ajayi et al., 1978; Imevbore and Ajayi, 1993). Awesu (1980); Akinnusi (1998) as well as Ayodele and Asimolowo (1999) stated that the conventional feeds for snails include bread fruit, water leaf, pawpaw leaf and fruit, sweet orange, mango fruit, ripe banana and plantain.

Cross River rainforest zone has variable environmental conditions such as vegetation, rainfall pattern, daylight hours, temperature and relative humidity. The variations in these conditions will likely influence the growth and reproductive performance of snail species including *Archachatina marginata* (ovum and saturalis). As a result of the variation in environmental conditions, three agro-ecological zones have been identified in the zone viz: Northern, Central and Southern agro-ecological zones (Ojanuga, 2006). The study was carried out in Calabar which belongs to southern agro-ecological zone, a humid tropical (rainforest) environment. While a lot have been done on the reproductive and morphometric characteristics of *Archachatina marginata* (Swainson) probably because of its abundance (Stievenart 1992, Ebenso et al., 2002, Ibom et al., 2008), not much has been done on the performance evaluation of juveniles of two sub species of this *Archachatina marginata* fed different diets of plant origin in the humid tropical environment. Thus, the aim of this study was to evaluate the performance of juveniles of subspecies of *Archachatina marginata* (ovum and saturalis) fed forages and the nutrient composition of these forages which serve as diets.

MATERIALS AND METHODS

Location of study

The study was carried out at the Snailery Unit (Botanic garden) of the Biological Sciences Department, University of Calabar, Calabar. This study area was chosen because it provided a near environment to the natural habitat of snails. The area is planted with plantain, banana and avocado trees which provided shade that protected the hutches and snails from direct sunlight and rainfall.

Construction of cages and soil collection

Cages with measurement 45 x 45 x 40cm were constructed using wood and wire gauze. The wire gauze was nailed to the sides of the wooden frame to form the top lid for proper ventilation. Mosquito net was nailed on the wire gauze to prevent flies from entering the cages. All the cages were raised on wooden stands measuring 40cm from the ground level. The stands were placed in containers of condemned engine oil to prevent ants and crawling predators from attacking the snails. Loamy soil was preferred because snails show preference for neutral to slightly alkaline soil. The pH range was 7.0 - 8.0. The soil was filled into each cage compartment to a depth of about 20cm from the base to enhance the burrowing activity of snail for egg laying and during unfavorable conditions.

Collection of forages and diets

The forages of choice used in this study were sweet potato, cocoyam, banana, pawpaw and okra leaves. This is because snails show preference for these feeds according to reports by Awesu (1980) and Imevbore (1990). The forages used for this study were collected from the botanic garden environment. The juveniles were randomly allocated to five treatment groups and fed these forages (sweet potato-T_1), (Cocoyam –T_2 (Banana-T_3), (Pawpaw-T_4) and (Okra-T_5) respectively. The forages were supplemented with a formulated ration containing 24% crude protein (CP) and 2,453kcal/kg metabolizable energy (ME) recommended for snails by Hamzat et al. (2008).

Experimental Snails

The experimental snails consisted of two subspecies of juveniles; *Archachatina marginata* ovum and *Archachatina marginata* saturalis with initial weight ranging between 1.75 - 2.15g and 1.98 - 2.06g, respectively. The juveniles (snailets) were obtained from the hatching of eggs laid by the adult (parent stock) snails of *Archachatina marginata* ovum and *Archachatina marginata* saturalis*.* A total of two hundred and forty (240) juvenile snails of two subspecies were used in this study with one hundred and twenty juveniles per subspecies. Twenty four snails each were randomly allotted to the five dietary treatments. The juveniles were allowed to acclimatize in the experimental Snailery for fourteen days before the actual commencement of the experiment which lasted for another four months (120 days).

Determination of Chemical Composition of Forages

The proximate chemical fractions of all the five types of forages feed used in this study were determined by the Standard Laboratory Methods of AOAC (1990).

Determination of Growth Performance Parameters

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Body weight gain: Each juvenile was weighed individually at the commencement of this study and weekly thereafter using the scout^{Tm}pro electronic scale having a sensitivity of 0.01g. The body weight gain for each juvenile snail was obtained by difference.

Feed intake and Feed Conversion Ratio (FCR): Feed intake was determined daily by the difference between quantity of feed served and quantity left over. The Feed Conversion Ratio (FCR) was also determined as the ratio of feed intake to weight gain.

Experimental design

The experimental design used in this study was a two way Randomized Complete Block Design (RCBD) and significant means were compared using the Fisher's Least Significant Difference (FLSD).

RESULTS AND DISCUSSION

The growth performance characteristics of juveniles of *Archachatina marginata* ovum and *Archachatina marginata* saturalis were evaluated for 16 weeks and results are presented in Table 1.0. Parameters evaluated were Feed intake, Feed Conversion Ratio and Weight gain. Results showed that juvenile snails of *Archachatina marginata* ovum consumed more of the diets (forages) than *Archachatina marginata* saturalis*.* The average feed intake of *Archachatina marginata* ovum *ranged from 5.16 - 10.28g while that of Archachatina marginata* saturalis ranged from 5.68 - 9.95g, respectively. Juvenile snails of *Archachatina marginata* ovum subspecies preferentially consumed (10.28g) banana leaves (diet 3) compared to 9.95g consumed by *Archachatina marginata* saturalis of the same diet. Similar preference was also observed in sweet potato leaves (diet 1) with *Archachatina marginata* ovum consuming 10.26g and *Archachatina marginata* saturalis 7.56g. All the five diets recorded significant (P<0.05) difference in feed intake between the two subspecies of juvenile snails. *Archachatina marginata* ovum fed banana leaves (diet 3) recorded the highest feed intake values. The results of feed intake for juveniles of both subspecies were lower than 12.81g and 11.79g for black-skinned and white-skinned juveniles respectively of the same subspecies as reported by Ibom et al. (2008). This trend is an indication that the different experimental diets depressed feed intake of the juveniles in this study. This result agrees with the observations of Lukefahr (1992) that high crude fibre of forage could hinder effective intake of feed. The author added that variation in feed intake may also be attributed to the difference in nutritional value of individual forage served to the juveniles.

Table 1 - Growth Performance of juveniles of *Archachatina marginata* ovum and *Archachatina marginata saturalis* fed forage as diets

Parameters (g)	*Archachatina marginata* ovum Diets					*Archachatina marginata saturalis* Diets					SEM	LDS	SIG
	1	2	3	4	5	1	2	3	4	5			
FI	10.26	6.66	10.28	6.71	5.16	7.56	8.72	9.95	5.68	9.28	3.26	1.63	*
FCR	18.90	24.52	29.96	23.77	18.64	36.55	18.91	18.56	19.15	42.69	37.01	25.58	*
WW	4.01	3.35	5.29	2.82	2.75	2.89	2.90	3.28	2.69	3.37	0.36	0.12	*
WWG	0.57	0.49	0.39	0.37	0.33	0.28	0.49	0.52	0.36	0.38	0.70	0.25	*

* Means are Significant at P < 0.05. Diets: 1= Sweet potato leaves, 2= Cocoyam leaves, 3 Banana leaves, 4 pawpaw leaves, 5= Okra leaves. FI:
FCR: Feed Conversion Ratio, WW: weekly weight, WWG: weekly weight Gain
SEM Standard Error of Mean. LSD: Least significant Difference.

Feed conversion ratio for juveniles of *Archachatina marginata* ovum ranged from 18.64 - 29.96 while those of *Archachatina marginata* saturalis ranged from 18.56 - 42.69. Juveniles of Archachatina *marginata* ovum fed diet 3 had the highest FCR (29.96) compared to the value (18.56) obtained for *Archachatina marginata* saturalis on diet 3. The more efficient conversion ratio obtained for *Archachatina marginata* ovum juveniles on diets 2,3 and 4 compared to those of *Archachatina marginata* saturalis was due to the fact that the former (*Archachatina marginata* ovum) on these diets (2,3 and 4) accommodated some of the nutrients required for efficient utilization of their diets than *Archachatina marginata* saturalis on the same diet. Also, result of FCR of *Archachatina marginata* ovum on diets 2, 3 and 4 revealed that cocoyam, banana and pawpaw leaves (diets 2, 3 and 4) were the most efficiently utilized. Similarly, result of FCR of *Archachatina marginata saturalis* on diets 1 and 4 confirmed efficient utilization of sweet potato and okra leaves (diets 1 and 4) by the juveniles. Results on weight gain showed a progressive trend throughout the feeding trial. The mean weekly weight gain ranged from 0.33g (diet 3) to 0.57g (diet 1) for *Archachatina marginata* ovum juvenile, while those of *Archachatina marginata* saturalis ranged from 0.28 to 0.52 g for diets 1 and 3 respectively. Mean weekly weight gain favoured *Archachatina marginata* ovum sub-species. The highest weight gain of 0.57g was obtained by the subspecies fed diet 1 with a corresponding value of 0.28g obtained by *Archachatina marginata* saturalis on the same diet. Mean weekly weight gains showed relative growth rate of the two subspecies on the different diets. Values of mean weight gain of juvenile of *Archachatina marginata* ovum on diet 1 are significantly (P<0.05) different from those of juveniles of

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Archachatina marginata saturalis on the five dietary treatments. Juveniles of *Archachatina marginata* saturalis showed depression in their weight gain which was not comparable to the values recorded by juveniles of *Archachatina marginata* ovum. This could be as a result of low level of protein, ash and mineral contents in the different diets. This finding was confirmed by Omole (2002) that weight gain of snail is directly proportional to the level of protein in the diet. Similarly, *Archachatina marginata* ovum on diet 3 recorded the highest weight (5.29g) compared to *Archachatina marginata* saturalis that weighted 3.28g on the same diet. The least mean weight was observed in *Archachatina marginata* ovum on diet 5 (2.75g) while *Archachatina marginata* saturalis had the least value on diet 4. The progressive increase in body weight of snails observed in this study is in agreement with the report of Odunaya and Akinyemi (2008). However the fast growth rate demonstrated by *Archachatina marginata ovum could* be due to their inherent genetic potential which is a bigger subspecies than *Archachatina marginata* saturalis*.*

The proximate composition of the forages (diets) fed to the juveniles is presented in Table 2.0. The results showed that the Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether extract (EE), Nitrogen free extract (NFE) and Ash contents evaluated in the diets ranged from 75.16 - 7.62%, 10.88 - 12.76%,74.45 - 19.68%, 1.68 - 2.69%, 31.10% - 32-63% and 12.63 -17.74%, respectively. Diet 5 had the highest Dry matter and Ash contents which was significantly different (P<0.05) from other diets. Diets 1 had the least dry matter and ash contents compared to other diets. The variation in dry matter content could be attributed to the difference in the amount of moisture present in each forage (diet) and also the time which the leaves were harvested and fed to the juveniles. The Crude protein values obtained in this study ranged from 10.88 - 12.76%. The highest CP content was recorded in diet 1 and the least in diet 5. Difference in the CP content of the diets (forages) may be as a result of the age of the forages which were harvested and fed to the juveniles. This finding was confirmed by the report of McDonald (1995) that Crude protein (CP) of forages decreases with plant age. The Ether extract (EE) in diets 1-5 were relatively low and almost evenly distributed, with diet 1 having the highest EE value and diet 5 the least value. The EE value from diets 1-5 were 2.69, 2.35, 2.62, 2.20 and 1.68% respectively. There was no significant difference (P>0.05) in EE among the diets. The EE value obtained in this study were higher than those reported by Ejidike et al. (2000); Ademolu et al. (2004) that is 0.80 and 1.62% respectively for the same forages. The Crude fibre (CF) values of the five diets (forages) fed to the juveniles of the two subspecies ranged from 14.4 - 19.48%. The results show a gradual increase in CF level due to the increase in age of the plants. Values of CF obtained were higher than those reported by Ejidike et al. (2000) as 12.1 and 0.15%, respectively. The difference could be due to the structural strengthening of the plant tissues by lignification. Furthermore, the Nitrogen Free Extract (NFE) of the five diets revealed a range from 31.10 - 32.63%. Diet 1 recorded the highest NFE value and diet 3 the least. The Ash content also recorded a similar trend with the highest in diet 5 and least in diet 1, respectively. There was significant difference (P<0.05) in the Ash content in diets 3, 4 and 5.

Table 2 - Proximate Chemical Composition of Experimental Diets (forages)

Diets / Fraction (Mg /100g)	1	2	3	4	5	SEM
Dry matter	75.16c	77.11b	79.50a	78.52a	79.62a	0.76
Crude Protein	12.76a	11.40b	12.62a	12.67a	10.88c	1.15
Ether Extract	2.69	2.35	2.62	2.20	1.68	3.47
Crude Fibre	14.45c	18.90a	19.68a	17.16b	16.68b	0.75
Nitrogen Free Extract	32.63	31.69	31.10	31.56	42.49	1.17
Ash	12.65c	12.77c	13.48c	14.93b	17.94a	12.24

a.b.c.d: Means on the same row with different superscripts are significantly different (P<0.05). Diets: 1: Sweet potato leaves, 2: cocoyam leaves, 3: Banana leaves, 4: pawpaw leaves, 5: Okra leaves. SEM: Standard Error of Mean.

CONCLUSION

Research results from this study revealed that juveniles of *Archachatina marginata* ovum consumed more feed which was efficiently converted and utilized than juveniles of *Archachatina marginata* saturalis . Evaluation of growth performance showed that the weight gain in juveniles revealed a significant difference (P<0.05) between the two subspecies. The proximate values of the diets were within the normal ranges for the forages fed to juvenile snails in this study.

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a) For journal:

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Kareem SK (2001). Response of albino rats to dietary level of mango cake. J. Agric. Res.Dev. pp 31-38.

Chikere CB, Omoni VT and Chikere BO (2008). Distribution of potential nosocomial pathogens in a hospital environment. African Journal of Biotechnology. 7: 3535-3539.

b) For symposia reports and abstracts:

Cruz EM, Almatar S, Aludul EK and Al-Yaqout A (2000). Preliminary Studies on the Performance and Feeding Behaviour of Silver Pomfret (Pampus argentens euphrasen) Fingerlings fed with Commercial Feed and Reared in Fibreglass Tanks. Asian Fisheries Society Manila, Philippine 13: 191-199.

c) For edited symposia, special issues, etc., published in a journal:

Korevaar, H., 1992. The nitrogen balance on intensive Dutch dairy farms: a review. In: A. A. Jongebreur et al. (Editors), Effects of Cattle and Pig Production Systems on the Environment: Livestock Production Science. 31: 17-27.

d) For books:

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analysis, 15th Edition. Washington D.C. pp. 69-88.

Pelczar JR, Harley JP, Klein DA (1993). Microbiology: Concepts and Applications. McGraw-Hill Inc., New York, pp. 591-603.

e) Books, containing sections written by different authors:

Kunev, M., 1979. Pig Fattening. In: A. Alexiev (Editor), Farm Animal Feeding. Vol. III. Feeding of Different Animal Species, Zemizdat, Sofia, p. 233-243 (Bg).

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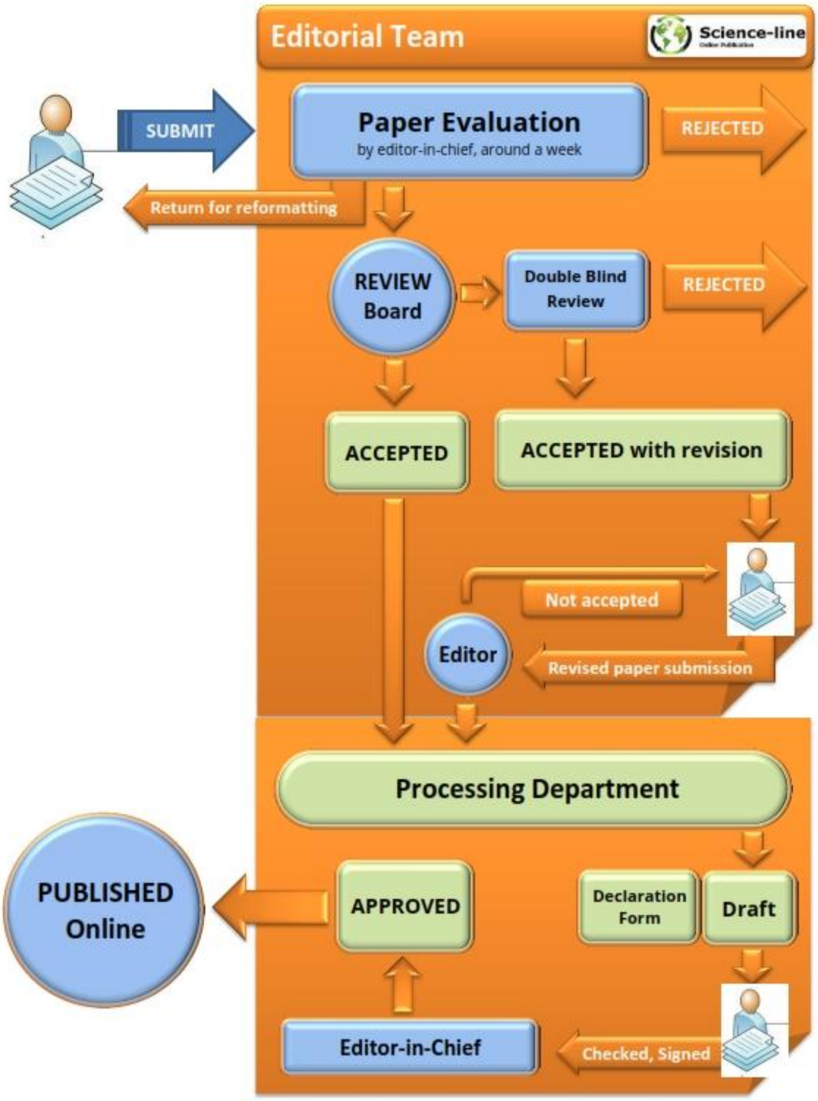

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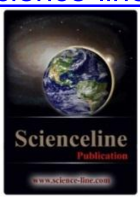

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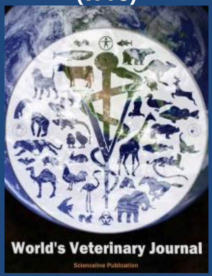

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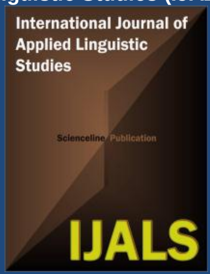

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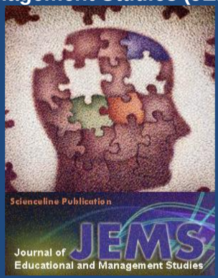

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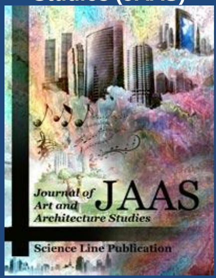

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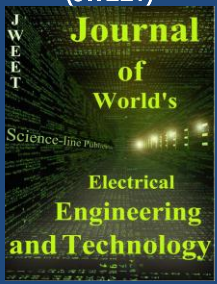

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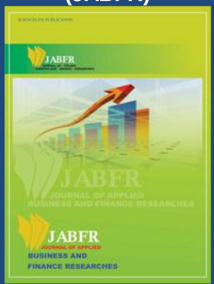

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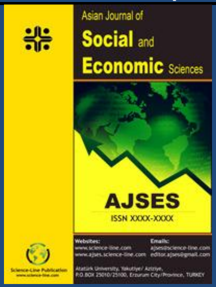

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