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Effects of mango waste-based rations on the technical-economic performance of local growing-finishing chickens in Burkina Faso

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ABSTRACT: The study assessed the effects of diets incorporating mango feed on the weight and economic performance of local chickens in finishing. To do this, three rations R1 (mango + corn bran) and R2 (mango + rice bran) and CR (without mango) each corresponding to a batch of 30 chickens were tested for 06 weeks. The results show that the final weight of R1 (1061±10 g) was significantly lower than those of R2 and CR (1208±206 g) ($p<0.05$). The voluntary food consumption of R2 (72±2.8 g/subject) was significantly higher than that of R1 (61.6±0.6g) and CR (62.39g) ($p<0.05$). The ADG of CR (9.24±3.26 g) was significantly higher than that of R1 (6.86±2.32g) and R2 (8.29±2.66 g) homogeneous ($p>0.05$). The consumption index (CI) and the food consumption for 01 Kg of live weight (FCkgLW) of R1 and R2 were significantly higher than those of CR ($p<0.05$). In conclusion, mango feed are an alternative to increased availability of feed for chickens. Experienced R1 and R2 rations can be recommended for the growth-finishing of local broilers. It will be necessary to assess the quality of carcasses and explore opportunities to reduce food production costs.

KEYWORDS: Mango waste-based rations, Local Chickens, Growth-Finition, Production costs.

1 INTRODUCTION

Poultry farming is increasingly taking on a strategic role in the fight against food insecurity and poverty in tropical countries [1], [2], [3]. Indeed, in the face of a high demand for animal protein and insufficient supply due to low productivity of domestic ruminants, the use of short-cycle animals whose poultry is increasingly encouraged [4]. In Burkina Faso, poultry farming is practiced in all localities by men, women and children [3]. In this country, traditional poultry farming is the most practiced by the population. It provides 90% of the poultry placed on the market [5] and provides a livelihood for rural populations. It provides them not only with a permanent source of protein but also with substantial income directly used by the family. According to [3], 69% of poultry products are intended for sale, 18.2% for donations and 13.3% for self-consumption. Among poultry, chickens are more numerically represented. Of the two main poultry species kept, chickens numbered 33,752,000 and guinea fowl 8,468,000[6]. The local hen represents 63% of the population compared to 37% of guinea fowl and 6% of other poultry in the North-East Region of Burkina Faso [3]. Despite its crucial importance in the lives of the populations, traditional

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poultry farming meets many constraints for its development, including food. Several factors are identified; low availability and high cost of food, low knowledge of food formulation and rationing techniques according to physiological stages [3] and low coverage of nutritional requirements of rations [7]. This situation is complicated by the competition between humans and poultry over cereal grains, particularly maize, which remains the main cereal used for poultry feed [8]. In order to find solutions to this constraint, research oriented towards the use of non-conventional food resources, [8], [9], [10], is being conducted. With this in mind, a process for the production of animal feed based on mango wastes has been developed by [11]. Thus, two feeds were produced during the 2014-2015 mango season for rationing tests on pigs, sheep and poultry. The purpose of this study is to evaluate the effects of the use of these feeds on the weight performance of local chickens in finishing.

2 MATERIALS AND METHODS

2.1 STUDY SITE

The study took place at the Farako-Bâ Research Station, at the Regional Directorate of Environmental and Agricultural Research (DRREA) of the Institute of Environment and Agricultural Research (INERA). The Station is located 15 km south of the city of Bobo-Dioulasso on the Bobo-Dioulasso - Côte d'Ivoire border road. Its geographical coordinates are 04°20'' west longitude and 11°06'' north latitude. The Farako-bâ station is located in the South Sudanese climate zone between the 1000- and 1200-mm isohyets (Guinko, 1984). The highest temperatures recorded at the station in 2015 were 31.04°C in April and 32.0°C in May and the lowest averages in January (21.5°C) and December (23.5°C).

2.2 CHARACTERISTICS OF THE HEN HOUSE

The henhouse used for the experiment is of the semi-open type. It is built of cement blocks with a cemented floor. The building is topped by a sheet metal roof with a unique east-facing slope. A 1.5 m roof overhang is a shade, which protects the subjects against bad weather. It is divided into three 5m^2 boxes with mesh partitions between them. The interior is illuminated by suspended bulbs. Two (2) 01m linear feeders and two (02) siphoid water troughs were placed in each box.

2.3 ANIMAL MATERIAL

Ninety (90) chickens between 4.5 and 5.5 months old acquired at a unit cost of 2000 FCFA were used for the experiment. In order to obtain a more or less homogeneous band in age and weight, and to ensure prior compliance with the health protocol to avoid diseases like New Castle disease, the chickens came from a single farm from Baguera in the far west of Burkina Faso. In the station the chickens were quarantined for 2 weeks before the experiment. At the end of the quarantine period, a health protocol was applied to them (Table 1).

Table 1. Health protocol applied to chickens undergoing experimentation at Farako-Bâ station, Burkina Faso

Period	**Prevented or treated disease**	**Drug/Vaccine used**	Method of administration
On arrival	Stress, avitaminosis	Tétracholivite®	In drinking water
After two weeks	New Castle	Itanew®	Intramuscular route
	Internal parasites	Multi-purpose deworming Poultry (VPV®)	Oral route
	Stress, avitaminosis	Amin total®	In drinking water
3rd Week	Internal and Eternal parasites	Intermectin®	In drinking water
	Avian smallpox	Vaccin inactif	Wing transfixion

The chickens were then identified by means of a label in the form of a strip made by us and wrapped around the wing. They were weighed and divided into 3 batches of 30 chickens each, 15 male and 15 female corresponding to the 2 experimental diets and a control. A random draw of the batches was then made to determine the destination of each ration. For each batch, feed and water were distributed every morning at 7am. Three (3) kg of feed were distributed per day in long metal linear feeder. The water was given *ad libitum*. Food refusals were weighed every morning after the impurities had been sorted. The chickens were weighed weekly using a 5kg electronic scale.

2.4 FORMULATION OF EXPERIMENTAL RATIONS

Peel+Pulp of Mango + rice bran (PPSR) and Peel+Pulp of mango+Maize bran (PPSM) feeds were produced using the process developed by Kiendrébéogo et al. (2013). The mango waste content of each feed is 55% of the dry matter (DM). A sample of each feed was taken and the chemical composition determined at the Animal feeding and nutrition laboratory, in French LANA of the EISMV in Dakar in 2015. The chemical composition of the feeds is given in Table 2. The percentage composition and digestible energy and nutrient intakes of rations are presented in Table 3.

Table 2. Content of different nutrients and Digestible Energy (DE) as a percentage of dry matter (DM) in PPSR and PPSM foods

Nutrients/Energy	PPSM	PPSR
DM (%)	92,42	92,79
Crude protein (%)	9,08	6,95
Fat (%)	8,34	8,79
Crude fiber (%)	14,44	13,86
MM (%)	7,43	16,02
Calcium (%)	1,93	1,6
Phosphorus (%)	0,42	0,38
Sodium (%)	0,41	0,3
Energie Digestible (Kcal/Kg DM)	1880,64	1650,9

Table 3. Percentage composition, bromatological values and cost of rations

Ingrédients	R1	R2	CT
Composition centésimale			
PPM+RB	46,2	-	-
PPM+ CB	-	51,2	-
Maize	24	23,5	48
Mill bran	-	-	34,7
Soya cake	11,2	7,2	7
Oyster shell Powder	2	2	2
Fish meal	5	5	5
Oil	8,25	7,8	-
Salt	0,3	0,3	0,3
Methionine	0,5	0,5	0,5
Lysine	0,5	0,5	0,5
CMV	2,0	2	2
Nutrients valus			
DE (Kcal/kg)	2 903	2 901	2 998
ME (Kcal)	2 757	2 756	2 848
Crude Protein (%)	14,02	14,59	14,38
Lysine (%)	0,83	0,96	0,89
Méthionine (%)	0,65	0,68	0,69
Calcium (%)	1,16	1,15	1,09
Phosphorus. (%)	0,31	0,31	0,29
Crude fiber (%)	5,55	4,88	4,54
Cost (FCFA/kg DM)	244,5	214,9	221,0

***CMV** : Vitamin and Mineral Supplement ; **FCFA** : Franc of the French Community of Africa ; **DM** : Dry Matter ; **DE** : Digestible Energy ; **ME** : Metabolizable Energy **; R1** : Mango Peel+Pulp+Corn bran base ration ; R2 : Mango Peel+Pulp+Rice bran base ration ; **CR** : Control Ration without mango waste.*

2.5 DATA COLLECTION AND ANALYSIS

The weight evolution was assessed by a weekly Weighing of the chickens at 6 a.m. before the distribution of the ration. Voluntary food consumption (FC) is calculated from the Following formula: FC(g) = (QFD - RF) / Number of chickens; with QFD = quantity of food distributed daily, and RF= food refusal; The average daily gain (ADG) is obtained by the formula ADG (g) = (final LW - initial LW) / number of days; The consumption index (CI) is calculated according to the formula CI = Amount of food consumed during the period (g) / weight gain during the same period (g). The economic valuation was made only on the basis of the food cost of production of one (01) kg LW. Thus, the food cost of production per kilogram of live weight (FC/kg LW) of chicken was determined according to the following formula: Food Cost/Kg of meat (FCkgLW) in F CFA = CI/ Price per kg MS of the food. The data were analyzed using XLSTAT Software Version 2007. Analyses of variance (ANOVA), using the LSD model ($p < 0.05$), were performed for the comparison of the means.

3 RESULTS

3.1 WEIGHT EVOLUTION OF CHICKENS

The initial and final average weights (Table 4) were homogeneous between R1, R2 and CR ($p>0.05$). In absolute values, the Initial Weights (IW) of R2 and CR subjects were higher than that of R1. The final average weight of R1 (1061±10g) was significantly lower ($p<0.05$) than those of R2 and CR homogeneous with each other (Table 4). The mean final weights of males in all rations were significantly higher ($p<0.05$) than those of females. Chicken growth was continuous throughout the trial for all rations (Figure 1 or 2). Subjects fed with R1 showed less growth than those fed R2 and CR

Table 4. Variation in average initial and final weights by ration

Rations	Chickens number	Initial Weight (g)	Final Weight (g)
R1	22	773±141^{a}	1061±10^{a}
R2	27	840±137^{a}	1188±155^{b}
CR	21	820±136^{a}	1208±206^{b}

The averages of the same column with the same letter are not significantly different at the 5% threshold.

3.2 TECHNICAL AND ECONOMIC PRODUCTION PARAMETERS ACCORDING TO THE RATIONS DISTRIBUTED

Table 5 shows the results for ADG, VC, CI and FCkgLW. The ADG (g) were significantly decreasing from CR, R2 to R1 ($p<0.05$). The VC was homogeneous between R1 and CR ($p>0.05$) and significantly lower than that of R2$p<0.05$). The CIs were homogeneous between R1 and R2 ($p>0.05$) and significantly higher than CR ($p<0.05$). The FCkgLW of R1 were significantly higher than that of CR ($p<0.05$). At the end of the trial, the chickens were sold at 3,000 CFA F/head. Average gross profit margins were comparable ($p>0.05$) between the three rations (Table 5).

Table 5. Variation in GMQ (g), CV (g), CI and CAPkgV (FCFA) between rations

Rations	N	ADG(g)	VC (g)	CI	FCkgLW (FCFA)	MB (FCFA)
R1	22	6,86±2,32^{a}	61,56±3,60^{a}	9,96±3,20^{b}	2409±780^{b}	138±123a
R2	27	8,29±2,66^{ab}	71,96±2,76^{b}	9,56±2,98^{b}	2058±641^{ab}	141±168a
CR	21	9,24±3,26^{b}	62,39^{a}	7,67±2,85^{a}	1696±630^{a}	180±286a

The averages of the same column with different letters are significantly different at the threshold of ($P<0.05$).

3.3 TECHNICAL AND ECONOMIC PARAMETERS ACCORDING TO THE RATIONS DISTRIBUTED AND SEX

The ADG of males of CR was significantly higher than that of females ($p<0.05$). The CI and males FCkgLW of CR were significantly lower than those of females ($p<0.05$) (Table 6).

Table 6. Variation in average initial and final weights by ration

Parameters	Rations	Chickens' number	Femelle	Male
ADG(g)	R1	22	6,89±2,58[a]	6,83±2,16[a]
	R2	27	7,76±2,77[a]	8,86±2,51[a]
	CR	21	7,35±2,2[a]	11,31±3,02[b]
IC	R1	22	9,93±3,53[a]	9,99±3[a]
	R2	27	10,45±3,38[a]	8,59±2,22[a]
	CR	21	9,20±2,66[b]	5,99±2,05[a]
FCkgLW (FCFA)	R1	22	2427±864[a]	2390±727[a]
	R2	27	2246±725[a]	1855±483[a]
	CR	21	2033±588[b]	1324±454[a]

The averages of the same line with different letters are significantly different at the 5% threshold

4 DISCUSSION

4.1 WEIGHT PERFORMANCE

Our results show a continuous growth of chickens from all rations during the trial period. The final average weights of R2 and CR rations are similar to those reported by [12] for village chickens in Congo. The final average weight of the R1(1061±10g) is very close to the average weights of 1107±190g and 1148±161g reported by [7], for local breed chickens 5-6 months old in small (N<30 subjects) and large (N>50 subjects) farms in the western part of Burkina Faso. Similarly, the average final weights of R2 (1188±155g) and CR (1208±206g) are almost close to the average final weights of 1259±161g reported by the same author for chickens of improved extensive farming type in Burkina Faso. The weight performance achieved by both the R1 and R2 CR ration are well within the average weight ranges reported by various authors cited by [2] for the 5-6 months age group in village settings in Senegal and Nigeria, and at stations in Senegal, Nigeria, Congo, Cameroon and Ethiopia. Our final weights are well below the 1689g average weight of improved traditional Sourou livestock farms in Burkina Faso reported by [3]. This superiority is due to the reference subjects in the case of the Sourou, which were hybrids resulting from crossbreeding between ISA Brown cocks and local chickens. The capacity of experimental rations incorporating mango to ensure good weight development and to be carried in the same way as the control ration of chickens growing at the finishing stage and ready to be sold for consumption is evident. The ADG (9.24±3.26g) of CR is almost equal to the ADGs of 9.31g and 9.5±05g for male chickens in stations, reported respectively by [12] and [13]. This confirms the relevance of our control ration. The ADG recorded for the R1 and R2 rations are higher than those reported by [7], which are 6.6g, 7g and 5.2g for the respective categories of small (N<30 subjects), medium (30≤N≤50) and large (N>50) livestock farms in the western part of Burkina Faso. On the other hand, they are lower, by 2.92g of R1 and 1.49g of R2 on average, than the ADGs reported by [12] and [13]. Depending on sex, the ADGs of males and females in R2 and CR rations are not significantly different; however, males were superior to females in the CR ration. This trend is in line with results reported by [14] in Chad and by [2] for several African countries. Indeed, male subjects are generally heavier than female subjects.

4.2 VOLUNTARY CONSUMPTION AND CONSUMPTION INDEX

Our results show a higher average consumption of the R2 ration than that of the R1 and CR rations. The VC of the latter two diets is in agreement with the average consumption of 60g/day reported by [2]. However, the absence of significant difference between the CIs and the average FCkgLW of the R1 and R2 experimental rations reveals the same level of value and food expenditure to produce 01 kg of chicken meat. Our CIs are higher than the 6.3 and 7.7g intervals of [15] and well supported by the 7.4-12.8g intervals of Senegal and Ethiopia reported by [2]. The evaluation of the digestibility of our rations would be necessary to better understand the actual availability of nutrients and Energy, which condition chicken growth. The levels and nature of the walls of mango-based foods could justify their lower digestibility compared to substituted maize, and the higher VC recorded at the level of the R1 ration. Indeed, several studies have shown that voluntary consumption depends strongly on the digestibility of the food. Thus, foods rich in fibrous substances are less well digested by poultry [16], [2], [17].

4.3 ECONOMIC PERFORMANCE

The food production costs per kg of live weight of 2,409FCFA and 2,058FCFA obtained for the R1 and R2 diets respectively are higher than that of the CR ration (1,669FCFA). Despite R2 significantly higher ADG compared to R1and CR, the average profit margins of the three rations were comparable. This clearly shows that from an income perspective, R1 and CR have closed the visible gap at the ADG level. The high cost of rations is undoubtedly due to the poverty of the feeds in Crude protein and the low level of energy contents compared to maize and bran, which required the incorporation of expensive feeds such as vegetable oil and soya cake and in the R1 and R2 rations in order to reach the desired equilibrium levels. However, R1 and R2 rations are cheaper than the formulas offered for sale by feed mills on the Bobo-Dioulasso market, which is in the range of 250 to 300 F CFA/kg. In addition, it is noted that no nutritional characteristics of the food sold on the market are given by feed mills, which does not ensure fair competition.

In view of the partial substitution of maize in the R1 (22.2%) and R2 (27.7%) rations and the total bran (37.4%) in both rations as well as the good weight performance recorded, we can conclude that mango waste feeds are an alternative to the low feed availability in poultry farming in Burkina Faso. In particular, the possible incorporation of mango waste into chicken feed shows the possible use of the mango waste-based pig feed production process [11], not only for pigs as demonstrated by the results of tests on growing pigs reported by [18], but also for various other species such as the local growing chicken finished in our case, and the Isa Brown pullets in preparation for laying [19].

5 CONCLUSION

The study shows that the use of mango feed ensures a good finish of local chickens as well as rations that did not contain them, formulated in Burkina Faso and elsewhere in Africa. Their incorporation in rations as a partial substitution for maize and a complete substitution for bran (maize, rice and others) makes it possible to make poultry feed more available by adding value to mango by-products that were once abandoned in orchards or thrown away after processing. Moreover, the use of these foods reduces competition between humans and animals around cereals such as corn. Despite the still high food cost of producing one kg of meat, the rations were less expensive than the food commonly sold in the Bobo-Dioulasso market square. In addition, rations that incorporate feeds make it possible to achieve margins comparable to the recommended standard rations. This could make them more accessible to farmers. Mango waste makes chicken feed more available. The costs of R1 and R2 rations are competitive because they were lower than the costs of formulas made from conventional feeds and sold on the Bobo-Dioulasso market. The use of non-conventional foods based on mango waste is recommended in poultry production. Real-world tests will be required to consolidate the positive results of this study. Finally, the technology for the production of feed based on mango waste disserves to be promoted to stakeholders in the breeding and mango sector.

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