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Milking Performance and Aflatoxin Residue in Milk of White Fulani and Sokoto Gudali Cows fed Commercial Diet

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Abstract
This study was carried out to assess the effect of commercially contaminated feeds on aflatoxin residue in milk of White Fulani and Sokoto Gudali cows. Three cows each of White Fulani and Sokoto Gudali breeds, averagely 250 kg body weight, five years old and in their second parity and mid-late lactation were fed a commercial dairy diet and a crop residue mixture basal diet (sorghum husk and beans husk at a ratio of 2:1) for a period of three months. Daily milk yield was collected, measured and bulked from where samples were subsequently analyzed for milk composition and aflatoxin M1. Results of milking performance showed that values of average daily concentrate intake of the cows were 5.1 and 5.0 kg for White Fulani cows and Sokoto Gudali and they differed significantly (P<0.05). The daily average husk intake of the Sokoto Gudali cow was higher (p<0.05) than that of the White Fulani, values being 7.5 and 7.4 kg respectively while average daily total feed intake of the cows was similar (p>0.05). The average daily milk yield of White Fulani, 0.38 kg was significantly (P<0.05) higher than that Sokoto Gudali cow 0.36 kg. With respect to milk constituents, the crude protein, crude fat, ash and lactose of White Fulani and Sokoto Gudali milk were: 10.23 and 11.50%; 3.58 and 3.43%, 5.07 and 4.07%, 0.99 and 0.81%, 7.60 and 4.83% and 2.01 and 2.67MJ/Kg respectively. The amount of aflatoxin M1 in milk of White Fulani and Sokoto Gudali cows were 0.47 and 0.49 ppb and were not significantly (P>0.05) different from each other. However, percent carry over rate of aflatoxin M1 in milk of White Fulani was significantly lower than that of Sokoto Gudali, the rates being 4.27 and 4.45% respectively. The study showed that aflatoxin B1 as low as 11 ppb in feed can result in 0.4 – 0.5 ppb aflatoxin M1 in the milk of cows eating such diets. It was concluded that aflatoxin contamination of dairy feeds led to milk aflatoxin contamination. It was recommended that dairy cow feeds should be preserved so as to prevent aflatoxin contamination, frequent analytical surveillance of dairy feeds and milk should be done to control incidences of mycotoxin contamination, insects that attack feed materials in storage should be controlled, and antifungal agents should be applied on grains.
***Key Word**: Milking Performance: Milk Aflatoxin: White Fulani cows: Sokoto Gudali cows*

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I. Introduction

Milk is a highly nutritious food obtained from the mammary gland and it's an important source of amino acids and minerals such as calcium and phosphorus, with adequate energy required for daily activities (Ndubueze *et al.,* 2006). The obvious benefits of milk as food have been considered by nations as an integral part of their food security program. This has informed various policies in Nigeria on dairy value chains aimed at bridging existing deficits in milk and milk product demand and supply due to low productivity of indigenous breeds (Nnadozie *et al.,* 2006). A number of factors ranging from environment to genetics have been considered as militating against adequate milk production in Nigeria (Tona *et al.,* 2015b). Studies of indigenous breeds like the White Fulani and the Sokoto Gudali indicated good milking potentials that can be upgraded through crossing and nutrition. Also, some exotic dairy breeds like the Holstein-Friesian and the Jersey breeds are currently producing milk competitively in commercial farms in Nigeria (Olafadehen *et al.,* 2013).

An important concern of the milk produced and other products in the dairy value- chain is the nutritional safety to the consumer and of course it's global acceptability for trade. Food safety concerns are global and essential trade issues that should be grappled and tackled at the level of production otherwise, the entire product risk losing commercial value. Food safety and security have become basic needs in our changing world with nations viewing physical, biological and chemical hazards as health and trade concerns (Chase *et al.,* 2013). Among chemical hazards of food and feed, mycotoxins have received global attention and have been characterized by the World Health Organization as a major security issue (WHO, 2002).

Animal feeds have been directly implicated in food safety, as they can be contaminated with a wide variety of compounds via a wide variety of sources (Cardwell *et al.,* 2002). Indeed, the detection of dioxins, mycotoxins, agricultural chemicals, industrial chemicals, microbial pathogens, veterinary drug residues, bovine spongiform encephalopathy and heavy metals in feeds has focused attention on the role of feeds in contamination of animal products from food producing animals (Chase *et al.*, 2013). Contaminations in food and feed are known to have serious effect on both consumers and the performance of food producing animals and the economic interests of livestock producers and traders (Alphonsus *et al.*, 2011).

The feed supply chain has traditionally made use of materials that are by-products from food processing. Over the past two decades, a number of by-products from the industrial sectors (e.g. factory trimmings, brewers dried grain, rendered meat and bone, etc.), previously used for other purposes or disposed of, are being used in feed. Such by-products may contain hazards such as processing additives and contaminants that are not known or routinely expected to be present in feed ingredients (Ahamefule *et al.,* 2007). From a mixed feed perspective, hazards in ingredients may carry forward into mixed feeds. Feed ingredient manufacturing processes are not always capable of removing or reducing certain hazards if present in raw materials or introduced into the ingredient (Chase *et al.,* 2013).

Generally, food safety guidance is in the purview of the Codex Alimentarius Commission which has detailed the relationship between the aflatoxin contamination in feed and feed stuffs of food producing animals and their products. It is an integral part of the World Trade Organization's Sanitary and Phyto-sanitary (SPS) agreement which aims to protect humans, terrestrial and aquatic animals and crops against exotic pests and diseases. Therefore, nations periodically undertake an assessment of food produced and/or imported and report such accordingly to ensure citizen confidence and health. It is in the light of the above that it is has become imperative for Nigeria with her comparative advantage in population and as a member of the World Trade Organization to be compliant with all protocols for trade in agriculture (FAO, 2007). In this milieu, this study was aimed at evaluating the milk yield, composition and aflatoxin residue in milk of lactating White Fulani and Sokoto Gudali breeds of cow fed commercial feed. The objective of the study was to evaluate the milk yield, composition and aflatoxin residue in milk of lactating White Fulani and Sokoto Gudali breeds of cows fed commercial feed.

II. Materials and Methods

Study Location

The study was conducted at the Nigerian Army Cattle Ranch, Giri Village, Gwagwalada, Abuja. Abuja is located between Latitude 9^0 03' 60"N and Longitude 7^0 28' 59.99"E. The area has an annual rainfall period of 6-8 months (March to October) and ranging from 155 – 284mm with a minimum temperature range of 23.9^0C and maximum temperature of 28.5^0C. The relative humidity range is between 64.5 to 69.5 (Tageo, 2009).

Experimental Design

Experimental Design used was the Completely Randomized Design

Experimental Diet

Commercially sold Ruminant Supplementary Ration for milk producing cattle were purchased and used as experimental diet, while a mixture of sorghum husk and cowpea husk at a ratio of 2:1 (SBHM) was used as the basal diet.

Experimental Animals and Management

Six multiparous lactating cows comprising three White Fulani and three Sokoto Gudali breeds with similar weight and milk production were selected from the Nigerian Army Cattle Ranch herd for the study. The cows were given 5.0 kg/cow/day concentrate diets between 9.00 -12.00am daily and subsequently allowed access to the SBHM and water ad-libitum.

3.4 Milking of Cows

The cows were hand milked once daily between 8.00 – 9.00 am. The calves were allowed to suckle briefly before hand milking so as to stimulate milk let down. Daily milk samples were collected in separate clean containers and samples collected daily and bulked in a refrigerator for laboratory analysis.

The total amount of milk yielded per day was recorded as the morning daily yield of the cow. The daily milk yield was then estimated for each cow on the assumption that actual daily production of cows can be met if the animals were milked twice a day, thereafter based on the concept of fixed milk yield responses to changing milk frequency (Erdman and Verna 1995). The constant 0.6596 was used as a weighing factor on the morning milk yield. Each day's milk (S) was estimated as;

$$S = M + 0.6596\ M$$

Where M is the morning milk yield (once a-day milking)

The quantity of milk harvested from a cow was measured using a graduated glass cylinder and weighted back to the nearest gram.

Proximate Composition of Feed Samples

Samples were collected from the concentrate and SBHM separately and analyzed for the proximate composition using the standard Method (AOAC, 2000) at the Animal Care Feed Analysis and Quality Control Laboratory, Ogere-remo, Ogun State.

Proximate Composition of Milk Samples

The proximate composition of milk samples was determined for dry matter, ash, crude protein (Nx6.38), fat, lactose and Milk energy (MJ/kg) by the Method of AOAC (2005) at the Animal Care Feed Analysis and Quality Control Laboratory, Ogere-remo, Ogun State.

Aflatoxin B1 and M1 analysis

The enzyme linked immunosorbent assay (ELISA) method was used for the aflatoxin B1 and M1 analyses at the Animal Care Feed Analysis and Quality Control Laboratory, Ogere-remo, Ogun State.

III. Results

Proximate Composition and Energy Content of the Experimental diets (Dry matter basis)

The proximate composition of the experimental diet is presented in Table 1. The dry matter value for the experimental diet was 88.08% while that of the basal diet (Sorghum husk + Beans husk mixture at ratio 2:1) was 98.20%. The crude protein (CP) content was 12.17% and 5.25% for the experimental ration and the basal diet respectively. The crude fibre content of the experimental diet was 10.98% and 26.94% for the experimental diet and the basal respectively. The NFE components were 48.98% and 55.67% for the experimental and basal diet. 15.75% and 8.50% were values reported for ash. The calculated ME for the experimental diet was 2180.95 kcal/kg and 1035.98 kcal/kg for the basal diet. Evaluation of the value for aflatoxinB1 contamination in the diet showed a value of 11.00 ppb.

Milking Performance of Lactating White Fulani and Sokoto Gudali Cows Fed Aflatoxin B1 Contaminated Diet

The milking performance of lactating White Fulani and Sokoto Gudali cows fed aflatoxin contaminated diet is presented in Table 2. The result showed that average daily concentrate intake of White Fulani was 5.1 kg and was significantly higher ($p<0.05$) than that of Sokoto Gudali which was 5.0 kg. Average daily crop husk intake of Sokoto Gudali was significantly higher ($p<0.05$) than that of White Fulani, values being 7.5 and 7.4 kg respectively. Average daily total feed intake of the all cows was 12.5 kg. Average milk yield was higher ($p<0.05$) for White Fulani (0.38kg) while Sokoto Gudali had lower ($p>0.05$) values for average milk yield (0.36kg). Similar trend was observed in values reported for crude protein, crude fat, ash and lactose. The Sokoto Gudali were observed to have higher ($p<0.05$) values for the remaining parameters (milk energy and dry matter). Significant difference ($p<0.05$) was observed in the values reported for Lactose (7.60%) in White Fulani and (4.83%) in Sokoto Gudali. The value reported was ME (MJ/kg) was also higher ($p<0.05$) in Sokoto Gudali (2.67) than White Fulani (2.01).

Table 1 Proximate composition of Experimental and Basal Diet (%)

Constituents	Experimental Diet	Basal Diet
Dry matter	88.08	98.20
Crude protein	12.17	5.25
Ash	15.75	8.50
Crude fibre	10.98	26.94
Ether extract	0.20	1.80
Nitrogen free extract	48.98	55.67
ME (MJ/kg)	2.15	1.98
Aflatoxin B1 (ppb)	11	0.17

ME= Metabolizable Energy obtained using the formula recommended by Pauzenga (1985) equation ME = (37 x %CP) + (81.8 x %EE) + (35.5 x %NFE). SBHM = Sorghum + Beans husk mixture at ratio 2:1

Table 2 Milking Performance of White Fulani and Sokoto Gudali Cows fed aflatoxin contaminated Diet

Indices	unit	WFC	SGC	P value	LOS	SEM
Exp. Diet	kg	5.10	5.00	0.00	*	0.05
Basal Diet	kg	7.40	7.50	0.00	*	0.05
Total feed intake	kg	12.50	12.50	0.00	NS	0.00
Av. Milk yield	kg	0.38	0.36	0.00	*	0.044
Dry matter	%	10.23	11.50	0.00	*	0.172
Crude protein	%	3.58	3.43	0.00	*	0.032
Crude fat	%	5.07	4.70	0.00	*	0.061
Ash	%	0.99	0.81	0.00	*	0.033
Lactose	%	7.60	4.83	0.00	*	0.115
Energy	MJ/kg	2.01	2.67	0.00	*	0.07

[ab] Means on the same row with different superscripts are significantly different (P<0.05) WFC = White Fulani cows, SGC = Sokoto Gudali Cows; * = Significantly different (P<0.05), LOS= Level of significance; SEM= Standard Error of the Means. ME= Metabolizable Energy obtained using the formula recommended by Pauzenga (1985) equation ME = (37 x %CP) + (81.8 x %EE) + (35.5 x %NFE). SBHM = Sorghum + Beans husk mixture at ratio 2:1

Residual Aflatoxin M1 level excreted in Milk from Aflatoxin B1 consumed in Feed

The result of the residual aflatoxin M1 (AFM1) excreted in the milk from the aflatoxin B1 (AFB1) consumed by White Fulani and Sokoto Gudali is presented in Table 3. The values reported for AFMI excreted in the milk of Sokoto Gudali were higher (p<0.05) than the values reported for White Fulani. The percentage secretion relative to AFB1 ingested from the consumption of contaminated feed was higher (p<0.05) in Sokoto Gudali than in White Fulani. The result in this study showed that the residual rates reported for both Sokoto Gudali and White Fulani ranged between 4.00 – 4.45%.

Table 3 Excretion Concentration for AFM1 in Milk of Lactating White Fulani and Sokoto Gudali cows fed aflatoxin B1 Contaminated Diet

Parameter	Unit	WFC	SGC	P value	LOS	SEM
AFM1 in milk	ppb	0.47	0.49	0.13	NS	0.024
% AFM1 in milk	%	4.27	4.45	0.000	*	0.087

[ab] Means on the same row with different superscripts are significantly different (p<0.05) AFM1 = Aflatoxin M1, AFB1 = Aflatoxin B1, WFC = White Fulani cows, SGC = Sokoto Gudali Cows; * = Significantly different (P<0.05), NS= Not significantly different (p>0.05); LOS= Level of significance; SEM= Standard Error of the Means

IV. Discussion

Proximate Composition and Energy Content of the Experimental Diets

The proximate compositions of the experimental diets are comparable to values indicated by Aduku (1993) as nutrient requirements for dairy cattle. The proximate composition of the basal and experimental diets showed that these diets could meet the minimum recommended levels of 12% crude protein and 25 to 28% fiber requirements for lactating cows (NRC, 2001). However, without the supplementation with concentrate, SBHM alone might not adequately provide the minimum 12% crude protein required. Also, the diets could fall short of the 8% crude protein needed for the minimum ammonia level for optimum functioning of the rumen (Norton, 1995). The range of 8.50 – 15.75% ash content of the experimental diets was within the 6.68 – 9.48% ash content of foliage plants recommended for ruminants feeding (Ogunbosoye *et al.*, 2015). Abdollahzadeh *et al.* (2010) suggested that the optimum dietary level of non-fibrous carbohydrates in dairy ruminant’s diets should be between 30 and 40% DM. In the current research, the non-fibrous carbohydrates content of between 9.77 and 49.71% was adequate to provide required nutrients for the experimental animals. Non fibrous carbohydrates contents of the diet in ruminants serve as a source of energy (Tona *et al.*, 2015b).

Milking Performance of Lactating White Fulani and Sokoto Gudali Cows Fed Aflatoxin B1 Contaminated Diet

The significant difference in both the average daily concentrate intake and average daily SHBM agrees with reports of other workers based on the practice of some ruminants preferring eating concentrates while other have preference for roughages (Madziga *et al.,* 2013). Similarity in average daily total feed intake by both cow breeds is attributed to a complementary effect whereby low intake of concentrate led to higher intake of crop residues and vice versa. This effect had also been reported by other workers (Ayoade *et al.*, 2015; Wuanor *et al.*, 2018).

Dry matter content of cow breeds milk observed in the present study is lower than the values of 14.80 – 15.20% reported by Salau and Bolakale (2012). The variation in dry matter content in the raw milk among the breeds may be due to the difference in composition of the milk of individual breeds and ruminants (Talukdar *et al*., 2013). Dry matter contents of cow breeds observed in the present study is lower the milk composition standard requirement of 12.00 – 14.00% (Talukdar *et al*., 2013).

Protein content of milk in this study being affected by cow breeds is in conformity with the work of Oladapo *et al.* (2015) who found significant difference in protein content among White Fulani and Sokoto Gudali cow breeds. The protein content of cow breed in the present study was higher than the 3.30±0.22% (Mirzaheh *et al.,* 2013), but lower than the 5.80 – 5.90% (Falola 2012) for White Fulani and Sokoto Gudali cow breeds. The protein content of the milk of cow breeds in the present study is comparable to the value of 3.56% stipulated as milk composition standard requirement (Talukdar *et al.,* 2013).

Fat contents of milk produced in this study is within the range of fat for milk composition standard requirement of (3.50 – 5.00%) (Talukdar *et al.*, 2013). The proportion of fat and protein in milk are determined primarily by the genetic make-up of the lactating animals, though they can be changed by nutrition and methods that adjust digestive and metabolic process (Adewumi and Olorunisomo 2009). Fat content of cow breeds in the present study is higher than the 4.60 – 4.70% reported by Oladapo *et al.* (2015) for Sokoto Gudali and White Fulani cow breeds. The values are greater than the earlier findings of Teklemichael (2012), who reported fat content of 3.86 to 4.30% in milk produced by indigenous cattle breeds in Ethiopia. Protein is required for body building and repair, while fat is widely known as a source of energy. Excess content of fat could constitute to health risk (Dandare *et al*., 2004).

The lactose content of cow breeds in the present study is within the 4.53 – 4.83% Oladapo *et al*. (2015) for SGC and higher in white Fulani cow breeds (Pavic *et al*., 2004). The range of lactose content of milk in this study (4.57 to 5.26%) cow is close to the 4.45% of the milk composition standard requirement (Nnadozie *et al.*, 2014). Ash content of the milk observed in the present study is close to the 0.79 – 0.81% (Oladapo *et al.,* 2015) for WFC and SGC. Lower ash contents were reported by Luigathurai *et al.* (2009) and higher range of 0.90 to 1.2% (Ndubueze *et al.,* 2006) for WFC. The ash content is an empirical measurement of the mineral constituent of foodstuff volatile component which is very essential in nutrition (Etonihu and Alicho, 2010). Difference in ash content among and across the breeds might be due to differences in total solids as the values could be positively correlated.

Residual Aflatoxin M1 level excreted in Milk from Aflatoxin B1 consumed in Feed

The Federal Department of Agriculture (FDA) has specified limits of aflatoxin of not more than 20 ppb in feeds of lactating animals and 0.5 ppb in their milk. A rule of thumb is that milk aflatoxin concentration equals about 1.7% of the total aflatoxin concentration in the total ration on dry matter basis (Diaz *et al.*, 2004). Cows consuming 30 ppb aflatoxin can produce milk containing aflatoxin residues above the FDA action level of 0.5 ppb. Aflatoxin M1 appears in the milk rapidly and clears within three to four days of consumption (Diaz *et al.,* 2004). The result of this study agrees with Price *et al.* (1985) and Petterson *et al.* (1989) who showed a direct correlation between milk yield and carry-over rates of aflatoxin. Fink-Gremmels (2008) has shown that factors that affect carry-over rate includes milk yield, species difference, general health of animals, hepatic biotransformation capacity, rate of ingestion and integrity of the mammary alveolar cell membrane. According to Diaz *et al.* (2004) and Masoero *et al.* (2007), the carry over rate in dairy cows milked twice daily was 1% - 2% of the ingested AFB1 for cows yielding less than 30 kg milk yield/day and 6% for cows yielding above 30 kg milk yield/day

V. Conclusion and Recommendation

Conclusion

It was concluded that aflatoxin contamination of commercial dairy concentrate of 11.0 ppb led to milk aflatoxin content of 0.4 to 0.5 ppb.

Recommendation

It was recommended that:

1. Dairy cow feeds should be screened and kept away from contamination as much as possible in order to limit the possible residual aflatoxin content in milk that could be deleterious to human health.
2. Frequent analytical surveillance by food control agencies should be carried out to control the incidences of Mycotoxins contamination, especially in dairy products.

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