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Microbiological Quality Assessment and Physico-chemical Properties of Selected Poultry Feeds from Commercial Feed Millers in Ilorin, Nigeria

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Abstract

Two commercial poultry diets namely chick mash and grower mash were obtained from five (5) major poultry feed millers in Ilorin metropolis, Nigeria. A total of seventy – five (75) samples were collected and these diets were examined for their microbiological and physico-chemical qualities. Total bacterial counts in the chick mash ranged between 1.40 and 6.60 x 10^5CFU g^{-1} while values obtained for the grower mash were 2.80 and 7.70 x 10^5 CFU g^{-1}. Similarly, Total fungal counts ranged between 2.20 – 8.90 x 10^6 and 5.60 – 14.0 x 10^4 CFU g^{-1} for the chick mash and grower mash respectively. These counts were irrespective of the feed producer. A total of twelve microorganisms comprising seven bacterial and five fungal species were isolated. The organisms were tentatively identified as Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Klebsiella sp., Proteus sp., Pseudomonas aeruginosa, Escherichia coli and Aspergillus niger, Rhizopus stolonifer, Aspergillus flavus, Coccidiolodes immitis and Geotrichum candidum. The pH and titratable acidity ranged between 5.0 – 6.8 and 10.80 – 20.00mg/100g respectively. Proximate analysis of the chick mash revealed the moisture content which ranged between 11.10 – 14.09%, crude protein 22.01 – 25.12%, total ash 8.70 – 12.50%, crude fat 3.20 – 5.05%, crude fibre 4.5 – 6.12% and total carbohydrate 50.49 – 57.21%. The range of values obtained for the grower mash were moisture content 7.29 – 9.31%, crude protein 12.47 – 16.85%, total ash 4.74 – 6.87%, crude fat 3.25 – 6.30%, crude fiber 5.65 – 9.45% and total carbohydrate 56.40 – 61.11%. The implications of these findings were discussed.

Key words: Poultry feed, microbiological quality, chick feed, growers mash.

Introduction

Poultry feed is derived from grains such as maize, barley, wheat, soybean, peanuts, bone meal and offal (Rosa *et al.* 2005; Davis and Wales, 2010). Poultry feed ingredients of both plant and animal origin are often contaminated with microorganisms, mostly bacteria and fungi and or insects which are of various types depending on the composition of the feedstuff material, its origin, climatic conditions encountered during harvesting, processing, storage, transport technologies employed and packaging materials (D' Mello, 2006).

Animal feeds are usually not subjected to the same stringent microbiological criteria and standards as the food consumed by humans. The use of poor quality ingredients has led to the production of poor quality feeds. The goal of the feed manufacturer is to supply the animals with feeds whose nutrients can be used by the animal when made available in a suitable form to its cells, organs and tissues. In performing this, the feed manufacturer is expected to be guided by the principles of least cost production of the livestock feeds, and the

production of quality products per unit of feed consumed at the least possible cost. Feed manufacture is a regulated business in the livestock industry to ensure the nutritional well being of the different livestock species, without which they will be out of business (Atteh, 2002).

Chick mash is commonly fed to day old birds up to when they are 4 weeks old, while growers mash is fed to growing animals with a well stabilized enzyme profile. Poultry feed has been reported to deteriorate if stored for more than 4 weeks from the time of mixing. This is because there is usually a decrease in feed quality with storage time. Animal feed may serve as carriers for a wide variety of microorganisms. There are numerous ways contaminating microbes can affect feed quality negatively including reducing dry matter, causing musty or sour odours, causing caking of the feed and producing toxins (Maciorowski *et al.*, 2007). Water seepage in any form predisposes animal feed to mold, and mold contamination can decrease nutritional value of feeds and affect animal health especially in the tropics where temperature and relative humidity are high. It is therefore necessary to control the microbiological quality of animal feedstuffs (Arotupin *et al.* 2007; Maciorowksi *et al.*, 2007).

The presence of moulds and mycotoxins in poultry feeds are usually from the raw materials used in their production. Mould and mycotoxin contamination of the raw materials can occur pre-harvest in field produced fungi and post-harvest in store produced fungi (Krnjaja *et al.*, 2008; Davies and Wales, 2010). Feeds may be contaminated by pathogens at any point in the production, storage, preparation processes. Pathogens like *Staphylococcus aureus* and *Escherichia coli* have been reported to be transmitted by the feed to susceptible consumers, where they grow and cause diseases, or a food borne infection (Church and Dupont, 1993). *Salmonella* spp. is the major hazard for microbial contamination of animal feed. *Listeria monocytogenes, E. coli* O157:H7 and *Clostridium* spp. are other hazards of less importance (Anon, 2008). A number of other pathogens have also been isolated from poultry feeds such as *Fusarium moniliforme,* Aflatoxigenic strains of *Aspergillus flavus, A. glaucus* group, *Salmonella senftenberg, S. montevideo, S. cerro, Bacillus cereus, Aerobacter aerogenes* among others (Jay *et al.*, 2005; Arotupin *et al.,* 2007; Lateef and Gneguim-Kana).

This study evaluated the microbiological and physicochemical qualities of chick mash and grower mash feeds produced in Ilorin metropolis, Kwara State, Nigeria with the aim of ascertaining the quality of feeds produced by the feed millers.

Materials and Methods

Collection of poultry feed samples

Fifteen (15) feed samples were collected from five (5) different feed millers in Ilorin metropolis, making a total of seventy-five (75) poultry feed samples. The samples were collected into sterile specimen bottles and taken to the laboratory, properly ground to fine particles (1 mm particle size) using the mill attachment of a Moulinex blender before analysis.

Determination of pH

The pH of the samples was determined with a Crison micro pH meter (Model 2000) which was standardized with buffers pH 4.0 and 7.0 (AOAC, 2000). One gram of the ground sample was suspended in distilled water in the ratio of 1:10. The suspension was allowed to stand for 30 minutes before reading.

Determination of Titratable acidity in the samples

The method of AOAC (2000) was used. 0.01M NaOH was titrated against 10ml of the filtrate using Phenolphthalein indicator. The end point was indicated by a change in color of the sample to pink. The amount of acid in milligrams per hundred grams feed (mg 100 g^{-1}) was calculated as percentage lactic acid.

Proximate analysis of the samples

The proximate analysis was determined according to the methods of AOAC (2000). The percentage moisture, dry matter, crude fat, crude protein, crude fiber and total ash were determined. The total carbohydrate was obtained by difference.

Total microbial counts of the samples

Total viable counts of the bacterial and fungal isolates using Nutrient agar (NA) and Potato Dextrose agar (PDA) respectively were determined using serial dilution and standard plate count method (AOAC, 2000).

Characterization and identification of microbial isolates from the feed samples

Pure cultures of bacterial isolates were characterized and identified using various biochemical tests as established by Holt *et al.* (1994). The fungal isolates were characterized and identified according to Samson and Von Reen-Hoekstra (1988); Onions *et al.* (1981).

Results and Discussion

A total of seven (7) bacterial and five (5) fungal species were isolated from the poultry feed samples. The isolated bacteria were tentatively identified as *Enterobacter aerogenes*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus mirabilis* and *Bacillus subtilis*. They were *Aspergillus flavus*, *Aspergillus versicolor*, *Geotrichum candidum*, *Rhizopus stolonifer* and *Aspergillus niger*. These organisms were distributed throughout all the feed samples (Table 1). *Aspergillus niger* was found to be the most widely distributed isolate, while *Proteus* sp. was the least distributed. Some of the bacterial isolates were of the family Enterobacteriaceae. Members of Enterobacteriaceae isolated from the feed samples have the potential of causing gastro-intestinal tract infections both in the poultry birds and human handlers and consumers (WHO, 1998; Wojdat *et al.* 2005).

Many of these organisms represent common environmental contaminants and their presence may indicate contamination from the environment and raw materials during processing. Rosa *et al.* (2005) reported the presence of *Aspergillus flavus* and *Penicillium citrinum* as the prevalent contaminants in animal feed. Other organisms reported by other workers are *Fusarium*, *Aspergillus*, *Rhizopus*, *Penicillium*, *Mucor* and *Alternaria* (Krnjaja *et al.* 2008). Animal feeds contaminated with *Salmonella* pose a risk of infection to livestock and therefore to the human food chain (Crump *et al.*, 2002; Rosa *et al.*, 2005; Krnjaja *et al.*, 2008). However, *Salmonella* spp., *Listeria monocytogenes* and *Clostridium* were not isolated from any of the feed samples in this study.

The highest total bacterial counts were recorded in the FM samples 6.60×10^5 CFU/g for chick mash and TF samples had 7.70×10^5 CFU/g for the growers mash. The AC samples recorded the highest Total fungal counts of 8.90×10^6 and 14.0×10^4 CFU/g of chick and growers mash respectively (Table 2). Animal feeds are adjudged not to be in compliance with International Microbiological Standards if they exceed 300,000 CFU/g for older animals and 500,000 CFU/g for younger animals (Anon, 2008). Therefore it was observed that all the feeds examined for this study were of poor microbiological quality and failed to meet international microbiological standards. Lateef and Gneguim-Kana (2014) reported that feed samples emanating from Ogbomosho, south-west Nigeria were all of poor microbial quality and were contaminated with coliforms, heterotrophic bacteria and fungi. High temperature and humidity coupled with poor storage conditions are all contributory factors to the high incidence of both bacteria and fungi in the tropics.

The most frequently occurring fungal isolate from the feed samples was *Aspergillus niger* while, the least was *Coccidiolodes immitis* that was isolated from chick mash (Table 3). On the other hand the most frequently occurring bacterium was *Staphylococcus aureus* while the least was *Klebsiella* species. The prevalence of

Staphylococcus aureus in the samples indicate contamination of the feeds by humans during processing.

The proximate compositions of the samples used in this study were obtained from different commercial feed millers. The range of values obtained for the chick mash were moisture (7.8-9.3%), crude fat (3.5-5.5%), crude protein (16.4-18.8%), crude fibre (3.8-5.5%), total ash (8.7-12.8%) and carbohydrates (52.8-57.7%) (Table 4). While the results obtained for the grower mash were moisture (8.2-8.7%), crude fat (6.6-8.6%), crude protein (13.5-16.8%), crude fibre (3.4-6.0%), total ash (4.8-6.4%) and carbohydrates (56.5-62.4%) (Table 5). These feed samples contain sufficient nutrients to support the growth of both bacteria and fungi. The pH and titratable acidity being near the neutral range (Table 6) also are favourable to microbial growth. The crude protein content of the starter feeds were generally lower than the recommended value of 23.0% as reported by Atteh (2002) for broiler starter diets while the values of moisture, carbohydrate and crude fibre seems to fall within acceptable standard in the two types of diets that were examined. The crude protein (range13.5-16.8%) obtained for the grower mash fall within the recommended range (Aduku, 1993; Davis and Wales, 2010).

In conclusion, it was observed that while most of the microorganisms isolated from the feed samples used in this study were common environmental contaminants, the overall microbiological quality of the feeds fell below international microbiological standards. It is important to minimize contamination of animal feeds through hygienic production and appropriate storage conditions. This can help to minimize contamination of feed ingredients and final products. Aseptic handling and processing of commercial and home mixed poultry feeds should be ensured, proper sanitation procedures should be carried out in storage facilities to ensure that all poultry feed is of good microbiological quality.

Table 1: Distribution of isolated organisms in different commercial feed samples

	Feed Samples									
	TF		**BF**		**FM**		**AC**		**PF**	
Microbial isolates	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash
B. cereus	+	-	+	-	+	-	-	+	+	+
Klebsiella sp	+	-	-	-	-	-	+	+	-	-
P.aeruginosa	-	+	+	-	+	+	+	-	+	-
S. aureus	+	+	+	+	+	+	+	+	+	+
E.coli	+	-	+	+	+	-	-	+	-	+
Proteus sp.	-	-	+	-	+	+	-	-	+	-
B. subtilis	+	+	+	+	+	+	-	-	-	+
A. flavus	+	+	+	-	+	-	-	+	+	+
C. immitis	-	-	-	-	-	-	+	-	-	-
G. candidum	+	-	+	+	-	+	-	-	+	-
R. stolonifer	+	+	+	+	+	-	+	+	-	+
A. niger	+	+	+	+	+	+	+	+	+	+

+ = Present
- = Absent

Table 2: Total microbial counts of chick mash and grower mash samples

Feed samples	Bacterial count		Fungal count	
	Chick mash ($x10^5$cfu/g)	Grower mash ($x10^5$cfu/g)	Chick mash ($x10^6$cfu/g)	Grower mash ($x10^4$cfu/g)
TF	5.4^{bc}	7.7^{c}	2.9^{b}	9.0^{b}
BF	1.4^{a}	3.6^{b}	2.2^{a}	9.5^{b}
FM	6.6^{c}	3.6^{b}	4.8^{c}	5.6^{a}
AC	4.8^{b}	2.8^{a}	8.9^{d}	14.0^{c}
PF	5.8^{c}	4.2^{b}	4.9^{c}	8.5^{b}
SEM	1.62	0.39	0.94	1.05

Key: TF -Total Feeds; BF - Balex Feeds; FM - Feed masters; AC - Animal Care feeds; PF-Bendel Feeds; Values with different superscripts are statistically different ($p \leq 0.05$); SEM = Standard error of mean

Table 3: Frequency of occurrence (%) of the microbial isolates in feed samples

Microbial isolates	Feed samples									
	TF		BF		FM		AC		PF	
	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash	Chick mash	Grower mash
B.cereus	1	0	6	0	3	0	0	4	1	4
Klebsiella sp.	2	0	0	0	0	0	2	1	0	0
P. aeruginosa	0	8	7	0	2	4	5	0	2	0
S. aureus	5	12	7	6	5	8	5	4	6	4
E. coli	2	0	3	4	2	0	0	3	0	1
Proteus sp.	4	0	6	0	2	4	2	0	0	0
B. subtilis	2	8	2	4	5	8	0	0	0	4
A. flavus	1	3	2	0	1	0	0	1	1	1
C. immitis	0	0	0	0	0	0	1	0	0	0
G. candidum	1	0	1	1	0	1	0	0	2	0
R. stolonifer	5	2	3	2	2	0	3	6	0	5
A. niger	6	8	8	12	5	8	7	8	6	7

Key: TF -Total Feeds; BF - Balex Feeds; FM - Feed masters; AC - Animal Care feeds; PF-Bendel Feeds

Table 4: Proximate composition of chick mash from the commercial feed samples

Feed samples	Proximate composition (%)					
	Moisture content	Crude protein	Crude fat	Crude fiber	Total ash	Carbohydrate
TF	9.3±0.08[a]	16.4±0.09[a]	3.9±0.11[b]	4.0±0.03[ab]	8.7±0.06[a]	57.7± 2.18[a]
BF	7.9±0.06[a]	17.5±0.04[a]	4.2±0.08[a]	4.8±0.05[ab]	12.8±0.09[b]	52.8±1.50[a]
FM	8.5±0.04[a]	18.0±0.02[b]	3.5±0.07[b]	5.1±0.i2[b]	9.8±0.12[a]	55.1±3.10[a]
AC	7.8±0.06[a]	18.2±0.06[a]	5.5±0.03[a]	5.5±0.09[b]	10.3±0.8[b]	54.7±2.60[a]
PF	7.7±0.03[a]	18.8±0.10[a]	3.6±0.01[b]	3.8±0.07[a]	11.8±0.06[b]	54.3±1.90[a]

Key: TF -Total Feeds; BF - Balex Feeds; FM - Feed masters; AC - Animal Care feeds; PF- Bendel Feeds
Values presented as Means±SD (n=15); Values with different superscripts are statistically different ($p \leq 0.05$)

Table 5: Proximate composition of growers mash from the commercial feed samples

Feed samples	Proximate composition (%)					
	Moisture content	Crude protein	Crude fat	Crude fiber	Total ash	Carbohydrate
TF	8.2±0.03[a]	13.5±1.65[b]	6.9±0.01[b]	3.4±0.07[a]	5.6±0.12[a]	62.4± 2.10[a]
BF	8.7±0.10[a]	15.0±2.30[ab]	7.5±0.03[a]	4.0±0.04[a]	5. 8±0.26[a]	59.0±1.10[a]
FM	8.7±0.06[a]	15.5±1.15[a]	8.6±0.08[a]	4.3±0.60[a]	6.4±0.09[b]	56.5±1.10[a]
AC	8.5±0.09[a]	15.7±1.30[ab]	7.8±0.06[a]	3.7±0.55[a]	5.6±0.06[a]	58.7±1.65[a]
PF	8.4±0.20[a]	16.8±1,16[a]	6.6±0.12[b]	6.0±0.75[b]	4.8±0.10[a]	57.4±2.10[a]

Key: TF -Total Feeds; BF - Balex Feeds; FM - Feed masters; AC - Animal Care feeds; PF- Bendel Feeds
Values presented as Means±SD (n=15); Values with different superscripts are statistically different ($p \leq 0.05$)

Table 6: pH and Titratable acidity of the chick mash and grower mash from the commercial feed samples

Feed samples	pH		Titratable acidity (mg/100g)	
	Chick mash	Grower mash	Chick mash	Grower mash
TF	5.4±0.24	6.6±0.27	0.330±0.002	0.042±0.001
BF	5.2±0.14	6.2±0.19	0.325±0.005	0.039±0.001
FM	5.3±0.18	6.3±0.15	0.280±0.003	0.044±0.002
AC	5.7±0.13	5.9±0.08	0.240±0.003	0.317±0.009
PF	5.1±0.08	6.3±0.18	0.452±0.007	0.045±0.005

Key: TF -Total Feeds; BF - Balex Feeds; FM - Feed masters; AC - Animal Care feeds; PF- Poultry Feeds
Values presented as Means±SD (n=15)

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