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Impact of Season and Storage Duration on the Nutritional Composition of Poultry Feeds in Plateau and Katsina States, Nigeria

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Abstract

Poultry feed plays a vital role in the growth and productivity of poultry, and its quality can be affected by several factors, including seasonal variations and the duration of storage. The purpose of this research was to determine the proximate analysis of poultry feed produced in Plateau State (North-Central) and Katsina State (North-West) of Nigeria in relation to the shelf life and season. The first feed sample (VF) was purchased from the major distributor in Jos, Plateau State, while the second feed (JF) was purchased from the factory in Funtua, Katsina State. For VF -Dry Season (DSVF), the proximate results all falls within the specified values declared by the Standard Organization of Nigeria (SON) for both the DSVF, DSJF (JF -Dry Season) and WSVF (VF -Wet Season) and WSJF (JF -Wet Season) feeds in the two seasons. The findings indicated a significant and strong positive correlation between crude fiber and ash content at 99 % confidence level. The results obtained for WSJF (wet season JF) shows that there was a significant moderate inverse correlation between moisture content (MC) and crude protein (CP) (-0.742, $P < 0.01$), and a moderate correlation between MC and crude fiber (-0.715, $p < 0.01$). JF had higher fat and ash than VF. This infers that moisture due to season, moderately led to decrease of crude protein and crude fibre of the two feeds. Despite these variations, both feed brands maintained their nutritional values within recommended limits. Proper storage conditions are essential for sustaining feed quality and poultry productivity. This study highlights the need for improved storage strategies to ensure optimal poultry nutrition and food security.

Keywords: Poultry, season, nutritional, food security, shelf life.

Introduction

Among the many divisions of agriculture, poultry farming stands out as one of the most practiced divisions in the world. This is because it serves as a healthy, palatable and economic source of food protein [1]. Nigeria is reported to be rearing 180 million birds, with a greater percentage in the southern part of the country [2]. It is known that feeding poultry is the largest cost among the rest of the other costs involved in the production process, which amounts to 70% of the total cost [3, 4].

However, the quality of feed can be affected by some factors such as storage conditions, shelf life, humidity, aflatoxin, proper ratios of the mineral profile, and proximate chemical content [5]. While previous studies have examined poultry feed composition, limited research has focused on the combined impact of seasonal variations and storage duration in different climatic zones of Nigeria. This study aims to bridge this gap by evaluating proximate composition changes over time in two commercially available feed brands.

The nutrients supplied by feeds have specific roles; hence series of nutritional analyses are performed on feeds, so that a judgment can be made as to their nutritive value and the part that they can play in meeting an animal's requirements [6]. The basic components in feed are protein, carbohydrates, fats, moisture, crude fibre and ash; and are prone to effects such as season, aflatoxin, and shelf life among others [7].

Seasonal changes, particularly the transition between the rainy and dry seasons, affect the availability of raw materials, feed manufacturing processes, and storage conditions, all of which can result in variations in the proximate composition of the final feed [8]. Furthermore, the shelf life of poultry feed, which is influenced by factors like temperature, humidity, and packaging, can lead to nutrient degradation over time, especially in suboptimal storage conditions [9].

[8] Reported that environmental factors, such as moisture (feed moisture content and relative humidity), temperature, light, and oxygen influence deteriorative changes and losses in feedstuffs. Excessive moisture, especially due to season promote mold and fungal growth, degrade the quality of feed ingredients like maize, soybeans, and wheat and results in lowered levels of protein and fat and can increase fiber content, which may negatively affect the digestibility of the feed.
Additionally, [24] reported that the Interaction of feed brands and storage conditions had significant effect on all the proximate parameters. poultry feed ingredients subjected to long-term storage at varying temperatures lost essential nutrients, especially fat-soluble vitamins, which are critical for poultry health.

In this research, two feeds produced by the leading poultry feed producers in Plateau and Katsina states were considered; considering the geo-political locations and the temperature difference in these places where the two factories are located. Plateau is expected to have lower temperatures while Katsina is having higher temperatures. We intend to see the effects of season and the storage periods on the proximate qualities of these two brands of poultry feed.

The proximate parameters were assessed and compared to the standard organization of Nigeria (SON) specifications for layer feeds as follows; Protein 16.00-16.50%, Fat to be 5.00max, Crude

fibre 7.00% max, Moisture 12.00% max and Ash to be 15.00% max. (SON, 2018).

Materials and Methods

Sample preparation

The feeds samples from each of the two locations were bought and labeled DSJF, WSJF and DSVF, WSVF. Indicating JF as the feed brand from Katsina State, and DS standing for dry season, WS for wet season. And VF standing for the feed brand from Plateau state. Eight bags each of 25 kg of each feed brand was purchased from the major distributors and kept in an aerated room on a wooden platform for the period of the analyses which was four months in each season (dry and wet of 2021/2022). The four months of analysis was to justify the shelf life of the feed which was 90 days as stated by the producers. The fourth month's analysis was to ascertain the degree of deterioration of the feed and to also confirm if the shelf life stated by the producers is really as specified. The samples were taken according to quartering system, properly mixed to homogeneity before analysis was carried out.

Determination of proximate content of commercially feed and

Moisture content

To determine the moisture content, 5 g of each of the milled composite feed sample (DSJF, WSJF, DSVF or WSVF) was weighed into a clean oven dried pre-weighed (W_1) petri-dish. The dish with its content was transferred to the oven and heated to a constant weight at 105^{o}C for 3 hr. This was thereafter transferred to the desiccator, cooled and weighed (W_2). The moisture content (in percentage) was calculated as using the below formula according to the [4]

$$\%MC_{wb} = \frac{W_1 - W_2}{W_1} \times 100$$

Crude protein content

The crude protein content of sample DSJF, WSJF, DSVF or WSVF was separately determined using micro Kjeldahl method according to [4]. To 1.0 g of the milled sample (DSJF, WSJF, DSVF or WSVF) in a petri dish, 7.00 g of K_2SO_4 and 0.80 g of $CuSO_4$ were added and transferred to a crucible into a digestion tube. After addition of 12 cm^3 of H_2SO_4 (concentrated), the digestion tube was inserted into the digester and heated at 420^{o}C for 45 min. Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia and other organic matter to CO_2 and H_2O. Ammonia gas was not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH_4^+) which binds to the sulphate ion (SO_4^{2-}) and thus remains in solution.

$N(feed, A, B \text{ or } C) \rightarrow (NH_4)_2SO_4$

Then the tube was removed and placed in tube rack. To the digested solution, 75 cm^3 of distilled water was added and allowed to stand for 5 min, then transferred to the distillation unit. A 25 cm^3 of 4 %

boric acid was measured into a conical flask, to which the receiving tube was inserted, and placed at the receiving end of the distillation unit, then the safety door of the receiving end was closed.

To start the distillation, the alkali button was pressed so as to discharge NaOH and initiate steam generation. The reaction which takes place is as follows:

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + 2H_2O + Na_2SO_4$

The mixture was steamed through, a process called distillation for about 5 -7 minutes to collect enough ammonium sulphate (about 25cm^3). The sodium hydroxide converted the ammonium sulphate into ammonia gas which was liberated from the solution and moves out of the distillation flask to the receiving flask.

$2NH_3 + 2H_3BO_3 \rightarrow 2NH_4H_2BO_3$

The ammonium borate formed was titrated directly with 0.1 N HCl. The titre value T which is the volume of acid used was recorded. The same process was done for the blank except that the sample was substituted with 1 g of sucrose, and titrated against 0.1 M HCl (B=blank value).

The concentration of hydrogen ion (in moles) required to reach the end-point is equivalent to the concentration of nitrogen that was in the original feed. The nitrogen content of the sample was calculated using the formula:

$$\% \, Nitrogen = \frac{(T - B) \times 14.01 \times N}{Wieght \; of \; the \; Sample \times 10}$$

Percentage protein was calculated thus:

$$\% \, Protein = \% \, Nitrogen \times Conversion \; Factor$$ (6.25)

Total ash content

A 5 g portion of the sample was weighed into a pre-dried and weighed (W_1) petri-dish and weighed (W_2), and heated in a furnace at 550^{o}C until completely incinerated. This was thereafter transferred to a desiccator and allowed to cool, then weighed (W_3) and recorded. The total ash content was calculated thus using the method described by [4, 21].

$$\% \, Ash = \frac{W_3 - W_1}{W_2 - W_1} \times 10$$

Crude fat content

A 5 g portion of the finely ground (DSJF, WSJF, DSVF or WSVF) sample was placed in a cellulose thimble paper and fat extraction was carried out using hexane in a 250 mL Soxhlet extractor for 6 hours at a temperature of 45 – 60^{o}C. The fat content was calculated as below:

$$\% \, Fat = \frac{W_2 - W_1}{W_3} \times 100$$

Where, W_1 = weight of empty flask; W_2 = fat extract + flask; W_3 = Weight of sample taken. This method was reported to be used by [15].

Crude fiber content

A 2.0 g of the defatted sample (W1) was taken into a 250 ml flat bottom quick-fit flask with 100 ml of

the fiber reagent added to the sample in the flask according to [4]. A reflux condenser was fixed to the flask and allowed in a heating mantle. The content was boiled in flask for 50 minutes by refluxing and shaking, often to ensure proper digestion of sample. The digested content was cooled and filtered. The residue was washed on the filter paper into a crucible (dish) with hot distilled H_2O. Then the content in the crucible was dried in an oven at 120°C-130^{0}C, and cooled in a desiccator, followed by the weight (W2). The crucible was then put in a muffle furnace at a temperature of 600^{0}C for six hours. This was removed, cooled and weighed (W3).

$$\%\ Crude\ fiber = \frac{W_2 - W_3}{W_1} \times 100$$

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) was used for all statistical analyses. Analysis of variance (ANOVA) was used to compare the means analytes as a function of season and storage, with significance determined at $p<0.05$.

The limitation during the sampling was buying the feed sample from the distributors; it was intended to purchase the feed sample directly from the company, but sales were not made in small scale, as needed for the research. However, these distributors are the key ones located closest to the production site. The feed was supplied to them the same week they were purchased, and the distributors followed all the storage conditions recommended.

Results and Discussion

Moisture Content (MC)

From Fig 1 and 2, the MC recorded for DSJF (in %) in the dry season for the four months are 6.680±0.0707, 5.340±0.0849, 4.490±0.0141 and 4.185±0.1061 while for DSVF (in %) these were 7.330±0.0566, 5.610±0.0990, 4.600±0.1131, 4.595±0.0071 for the four months (June to September). MC correlated strongly and inversely at 99 % confidence with the duo of CP (-0.870) and Time (-0.940) in DSJF; while MC with Ash content (AC) was -0.607, $p < 0.05$), and MC with Time (-0.921, $p < 0.01$). Generally, it was seen that the moisture decreases with time across the four months of the research in both locations for the dry season which shows that the storage room was drier or less humid. This is true in both locations as the weather conditions in the dry season were really dry. The feed samples were stored under room temperature of 25°C all through the period of the research.

Similarly, for the wet season, WSJF recorded values (in %) for the four months as 7.485±0.1344, 7.760±0.1556, 8.885±0.1061, 7.660±0.0990 and WSVF as 9.090±0.2970, 10.560±0.0283, 10.935±0.0071, 8.795±0.0495 (Table 2). The results obtained for WSJF shows that there was a significant moderate inverse correlation between

MC and CP (-0.742, $p < 0.01$), and a moderate correlation between MC and C. fiber (-0.715, $p < 0.01$). For WSVF, there was a moderate inverse correlation ($p < 0.05$) with CP (-0.606). All these values fall below the recommended maximum limit of 12 % (SON) which is good a satisfactory one for good poultry practice. It was noticed that the moisture significantly went up in the second and third month for both feeds before declining in the fourth month. This shows that the atmosphere was humid as the rainfall within these months was intense. At the fourth month, there was decrease in the rainfall which has direct reflections in the moisture of the feed samples under studies. Based on these results, farmers are therefore advised to ensure proper safekeeping of their feeds during wet seasons as the tendency for them to increase in moisture is high especially between the months of June to August.

Crude protein (CP)

From Table 1, CP for DSJF increased from 20.295±0.2758 % at the beginning of the analysis (November 2021) to 21.470±0.1838 % after two months, and then 21.675±0.0354 % at the third month. However, the crude protein content slightly dropped to 21.600±0.1131 % after the fourth month. Similarly for DSVF, though it recorded lower values in comparison to that of DSJF, it also followed a similar trend, and increased from the start to the second month (18.455±0.1202 % at 0 month, 18.820±0.1980 % at 3 month). At third months, CP content started dropping and this continued through to the fourth month (18.365±0.0778 at third month, 18.180±0.0283 at fourth month).

The variation in the CP values obtained for DSJF and DSVF is associated with some factors, including moisture content due to humidity and abundance of rainfall relative to location as well as industrial practices and manufacture. The crude protein (CP) was discovered to be within the stipulated range of values (17 % - 23 %) for CP reported in literature. The relationship between CP and time was positively strong (0.794) and significant ($p < 0.01$). Also, CP had a strong and significant inverse relationship (-0.870) with moisture. The correlation between CP and fat, CP and crude fibre, CP and ash was weak and insignificant

The results obtained during wet season showed a different trend from the one recorded at dry season. There was a steady decline in the CP values analyzed for the WSJF and WSVF for the period observed. From the first through second, third and fourth months, the values obtained were 18.960±0.0849 %, 18.944±0.0651 %, 18.239±0.0530 % and 18.490±0.0424 % respectively. WSVF recorded 17.080±0.0141 % at the start, 17.009±0.0361 at two months, 17.006±0.0000 and 17.070±0.0849 at three and four months. There was a significant strong inverse correlation between CP and moisture (-0.742 at 99 % confidence), CP and time (-0.760 at 99 % confidence), while the relationship between CP and fat was moderately positive (at 95 % confidence).

Crude fiber and CP, CP and ash correlated weakly and insignificantly.

Generally, the result obtained showed that at both sampling locations, CP content was higher during dry season than during wet season. The variation in the CP content of DSJF and DSVF for dry season, and WSJF and WSVF for wet season is due to the processing methods as different companies have different methods of processing as reported by [18, 6]. Acquisition of varying quality of raw materials for the formulation of the feeds by companies has also been implicated to account for the different CP values recorded [10].

CP, which is needed as amino-acid is necessary for development of feathers, growth of carcass and the production of egg [14, 8]. The values obtained here for both dry and wet season here show that the birds fed with these feeds will benefit from the above mentioned dividends.

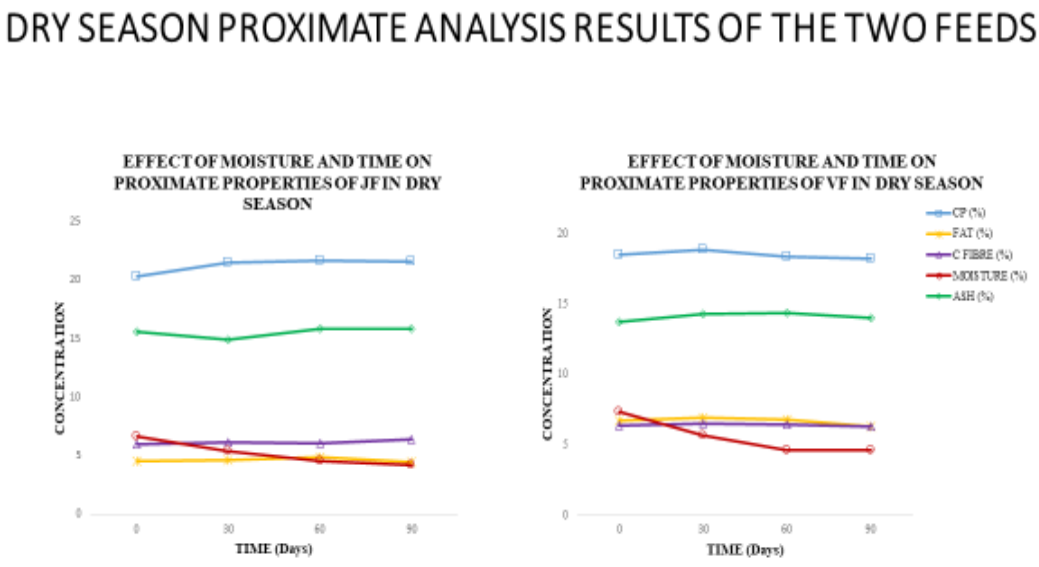

Fig 1: Proximate results for both the feeds in dry season, the curves showing the variations in respect to season (moisture) and time (shelf life)

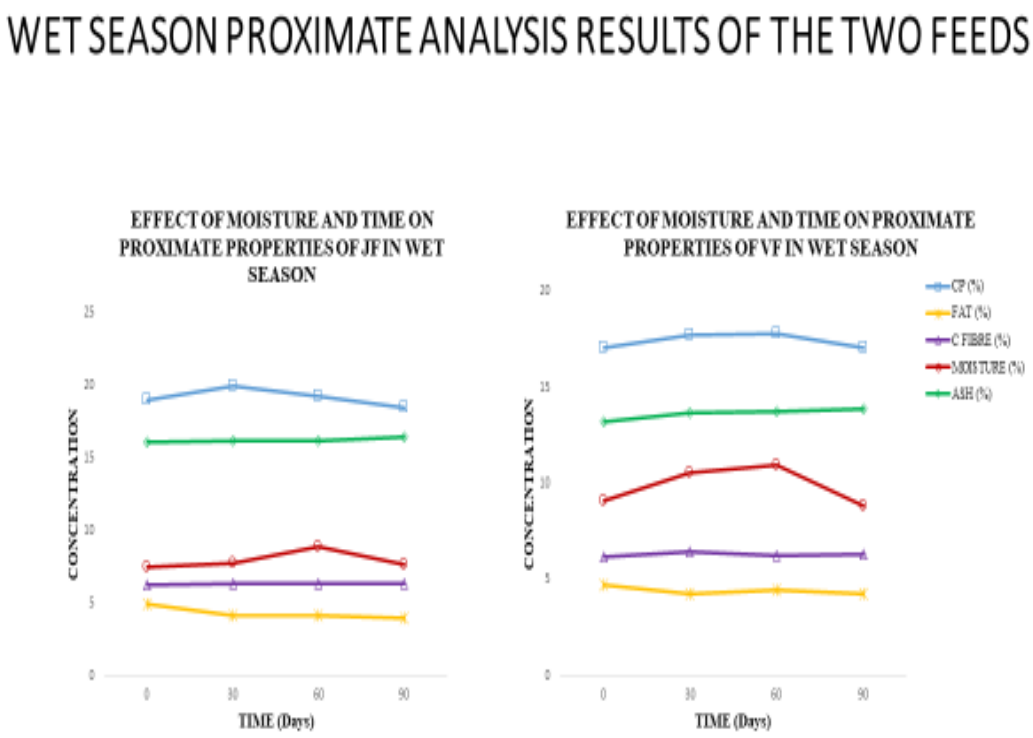

Fig 2: Proximate results for both the feeds in wet season, the curves showing the variations in respect to season (Moisture) and time (shelf life)

Ash content (AC)

Ash content (AC) correlates to the amount of inorganic content that is present in the feed [9]. From Figure 1 and 2, the AC recorded were 15.615±0.1626 %, 14.935±0.0636 %, and 15.810±0.2404 %, 15.885±0.0495 % at the start, one month, two months and three months respectively for DSJF. For DSJF, there was no significant relation between AC and any other proximate parameter. DSVF on the other hand had 13.718±0.1513 % at the start, 14.295±0.0778 % after a month, 14.360±0.0849 % and 13.965±0.2051 % at the second and third months. DSVF recorded a moderate positive correlation with both CF (0.599, $p < 0.05$) and C. Fiber (0.720, $p < 0.01$). Also, there was a moderate inverse correlation with moisture content (0.507, $p < 0.05$).

At wet season, however, AC was slightly elevated in WSJF with a value of 16.085±0.0636 % at the start, 16.135±0.0495 % at one month,

16.130±0.0566 % at two months and 16.425±0.0495 % at three months.

There was no significant correlation of AC with other parameters analyzed. Similarly, WSVF recorded 13.718±0.1513 % at first analysis. The analysis carried out after a month gave 14.295±0.0778 % while after the second month, the result was found to be 14.360±0.0849 %. The third month yielded 13.965±0.2051 %. There was a strong inverse correlation (-0.844, $p < 0.01$) between AC and CF. Also, C. Fiber had a moderate positive correlation (0.682, $p < 0.05$) with AC. The relationship between AC and time was also strongly positive (0.887, $p < 0.01$)

These values were below the values reported in a related research, carried out by [2] whose values were as high as 39 %. Elevated ash content has been implicated in bone and associating joint problems as well as crystal formation along the urinary tract. In comparison with the values obtained in literature, the above result is within the safe range [22].

Crude fat content (C. Fat)

Fat soluble vitamins are easily adsorbed in poultry diet with the aid of crude fat. C.Fat also makes feeds to be palatable [7, 19]. During the dry season, there was a steady increase in the CF content for the first three months for DSJF: 4.520±0.0849 % at the start, 4.575±0.0495 % at two months, and 4.825±0.0495 % at three months. Then a decline to 4.430±0.1273 % was recorded at four months. For DSVF, a value of 6.665±0.1344 % was recorded at the start and it increased to 6.880±0.0990 % after two months, after three months, the value declined to 6.775±0.0919 % and then to 6.295±0.1485 % after the fourth months.

The decline in the C.Fat content might not be unconnected with changes in weather from dry to wet season after three months. C. Fat content for DSVF were higher than the set standard value (5.0%). There was weak correlation between C. Fat and other proximate parameters, and the relationship was not statistically significant.

At the wet season, there was a steady decline in the C. Fat content of WSJF from the start 4.895±0.0495 %, through to the second (4.175±0.1202 %) and third (4.1458±0.0212 %) months and then at the fourth month (3.985±0.1344 %). Similarly, WSVF sample recorded 4.725±0.0354 % at the start, 4.28±0.0707 at the second month, 4.145±0.0636 at the third month and 4.255±0.2341 at the fourth. These values are below the maximum permissible limit of 5.0%. The value in this study also agree with the result reported by [12] whose values were all below 5.0 % for selected commercial feeds in Nigeria. There was a moderate correlation between C. Fat and CP (0.613) at 95%, strong inverse correlation between CP and time (-0.859) at 99 % confidence.

Crude fiber (C. Fibre)

C. fiber is needed for the digestibility of lower nutrients in monogastrics [5]. C. fiber content obtained at dry season for DSJF followed the following pattern: at the start 6.000±0.1131 %,

6.095±0.0354 % and 6.005±0.0212 % at the second and third month, and 6.410±0.0283% at the fourth.

DSVF on the other hand had 6.325±0.0212 %, 6.485±0.0495 %, 6.390±0.0141 %, 6.285±0.0212 % for the start, second, third and fourth month respectively. These values are all within the permissible level of 7.0 % (ISO 6865:2000). There was a significant and strong positive correlation between C. fiber and ash content at 99 % confidence. The relationship between C. fiber at dry season and other proximate parameters was not statistically significant.

In a similar way, 6.22±0.0424 % was recorded for WSJF during the wet season. The analysis carried out at the second and third month gave 6.34±0.0141 % and 6.365±0.0495 % respectively, while at the fourth month it was 6.300±0.0424 %.

For WSVF, 6.145±0.0071 % was obtained at the start, 6.435±0.0919 % after the second month, 6.250±0.0424 % at the third month and 6.330±0.0449 at the fourth month. At wet season, there was a moderate inverse relationship (-0.607) between C. Fiber and C Fat at 95 % confidence. Moreso, at 99 % confidence, there was a strong positive correlation between C. Fiber and moisture.

Table 1: Proximate analysis of the two feeds (JF and VF) in 4 months of dry season, (November 2021 –February 2022)

SAMPLE/PARAMETER	C. Protein (%)	Fat (%)	Crude fibre (%)	Moisture (%)	Ash (%)
NOVEMBER JF	20.295±0.2758	4.520±0.0849	6.000±0.1131	6.680±0.0707	15.615±0.1626
DECEMBER JF	21.470±0.1838	4.575±0.0495	6.095±0.0354	5.340±0.0849	14.935±0.0636
JANUARY JF	21.675±0.0354	4.825±0.0495	6.005±0.0212	4.490±0.0141	15.810±0.2404
FEBRUARY JF	21.600±0.1131	4.430±0.1273	6.410±0.0283	4.185±0.1061	15.885±0.0495
NOVEMBER VF	18.455±0.1202	6.665±0.1344	6.325±0.0212	7.330±0.0566	13.718±0.1513
DECEMBER VF	18.820±0.1980	6.880±0.0990	6.485±0.0495	5.610±0.0990	14.295±0.0778
JANUARY VF	18.365±0.0778	6.775±0.0919	6.390±0.0141	4.600±0.1131	14.360±0.0849
FEBRUARY VF	18.180±0.0283	6.295±0.1485	6.285±0.0212	4.595±0.0071	13.965±0.2051

SPECIFICATIONS	**16.50 (min)**	**5.00 (max)**	**7.00 (max)**	**11.00 (max)**	**15.00 (Max)**

Table 2: Proximate Analysis of the two Feeds (JF and VF) in 4 months of the Wet Season (June 2022 –September 2022)

SAMPLE/ PARAMETER	**CP (%)**	**FAT (%)**	**C FIBRE (%)**	**MOISTURE (%)**	**ASH (%)**
JUNE JF	18.960±0.0849	4.895±0.0495	6.220±0.0424	7.485±0.1344	16.085±0.0636
JULY JF	18.945±0.0636	4.175±0.1202	6.340±0.0141	7.760±0.1556	16.135±0.0495
AUGUST JF	18.235±0.0495	4.145±0.0212	6.365±0.0495	8.885±0.1061	16.130±0.0566
SEPTEMBER JF	18.490±0.0424	3.895±0.1344	6.300±0.0424	7.660±0.0990	16.425±0.0495
JUNE VF	17.080±0.0141	4.725±0.0354	6.145±0.0071	9.090±0.2970	13.205±0.0354
JULY VF	17.705±0.0778	4.280±0.0707	6.435±0.0919	10.560±0.0283	13.695±0.0495
AUGUST VF	17.760±0.0283	4.415±0.0636	6.250±0.0424	10.935±0.0071	13.760±0.0424
SEPTEMBER VF	17.070±0.0849	4.255±0.2341	6.330±0.0449	8.795±0.0495	13.850±0.0141
SPECIFICATIONS	**16.50 (min)**	**5.00 (max)**	**7.00 (max)**	**11.00 (max)**	**15.00 (max)**

Conclusions and recommendations

From the study, it can be concluded that:

Both the dry and wet seasons, as well as shelf life have varying effects on the proximate parameters of the two brands of the feeds in the two geo-

political zones, (Plateau and Katsina States). These effects are parameter dependent. From this research, it was discovered that as long as feed is allowed to come in contact with water and given to the birds, it can lead to several health challenges to the birds such as fungal growth which leads to the growth of aflatoxin, a mycotoxin which is both dangerous to the birds and humans. For a biosafety of the birds and humans, the farmers and producers must ensure the safety of the feeds and shelf life instructions are taken seriously.

Recommendations

Poultry feed in Nigeria is a very important source of income, as well, healthy animal protein is a critical index to the growing populace. It is a field that should be given proper attention. As a results of this, the following recommendations are drawn for further research:

i. The analysis was done within 4 months for each season, further work should be done in other months like March, April and May in other to see whether there can be different results obtained.
ii. It is also recommended that feeds from other brands be analyzed for a comparative work with the two already analyzed in this research.
iii. Also, further studies should include the analysis of the various raw materials being used in the formulation of the feeds
iv. This research focuses on layer feeds, further studies should be conducted on other variants of poultry feeds, such as the broiler rations.
v. At all cost, famers should avoid water coming close to feeds, as it is the primary cause of feed degradation, and reduction of quality with shelf life.

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