



Proximate Composition of Differently Treated and Fermented Corn Cob Flakes

Eniolorunda O. O., *Olamilusi, O. D., Dawodu, M. E. and Salami, O. A.

Department of Animal Production, Faculty of Agricultural Production and Renewable Resource, College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro Campus, Ayetoro, Ogun State, Nigeria.

Abstract

This study was carried out to determine the effect of treatment on the nutritive value of corncob flakes. The experimental material was corn cob flakes which were allotted to seven treatments and designated as T0, T1, T2, T3, T4, T5 and T6 with four fermentation durations (0, 15, 30 and 50 days) in a completely randomized design. The diets were designated as T0 (1 litre of water per 2 kg of corn cob flakes); T1 (100% potassium phosphate per litre of water, for 2 kg corn cob flakes); T2 (50% potassium phosphate + 50% of bicarbonate of soda per litre of water, for 2 kg corn cob flakes); T3 (100% of bicarbonate of soda per litre for 2 kg corn cob flakes); T4 (50% bicarbonate of soda + 50% of cellulase enzyme per litre of water, for 2 kg corn cob flakes); T5 (50% potassium phosphate + 50% of cellulase enzyme per litre of water, for 2 kg corn cob flakes) and T6 (100% of cellulase enzyme per litre for 2 kg corn cob flakes). The results for proximate composition showed significant ($P<0.05$) increase in DM, CP, EE and Ash as fermentation duration progressed. Conversely, significant ($P<0.05$) reduction occurred in the fibre fractions and phytochemical properties as fermentation progressed. It is therefore concluded that fermenting corn cob with 50% feed additives (either sodium bicarbonate or potassium phosphate) and enzyme for up to 50 days improved the proximate composition and reduced fibre fractions and phytochemical properties.

Keywords: corn cob, feed additives, nutritive value, fermentation duration

Introduction

The demand for animal products (meat and milk) has increased significantly in recent years and will likely continue to do so in the foreseeable future. This is due to the amount of land used for forage production as a result of the greater population growth rate and the pressure it causes, since feed scarcity has been the main issue preventing the expansion of ruminant animal production in Nigeria (Devendra and Leng, 2011). Ruminants can produce, even during the dry season when feed is scarce, and of low nutritional value (Aye, 2007; Olamilusi *et al.*, 2019). As feed is the primary driver of livestock productivity, accounting for more than 65% of recurrent expenditures, effective feeding of livestock is required to reach targeted levels

of output (Devendra and Leng, 2011). Therefore, to prevent shortages for feeding diverse classes of ruminants, ruminant nutritionists must concentrate on substitute feedstuffs that have no direct nutritional value for humans (Ojebiyi *et al.*, 2002; Aderolu *et al.*, 2011).

Maize cob is one of these leftovers that has a potential future in animal feeding. Wastes from dried corn shells known as corn cobs are in high demand among farmers for use as animal feed due to their ample supply and 20% corn content in waste products. Eniolorunda *et al.* (2021) claimed that well-processed corn cob may be offered to ruminants as either their primary source of energy or as a supplement to low-quality diet or foliage. Thus, the utilization of corn cob is

still of low quality in terms of protein content with high crude fibre content (Olamilusi *et al.* (2019). This is due to the interlocking of cell wall polysaccharides (up to 15%) with the resistant biopolymer lignin, preventing their microbial biodegradation in the rumen and lowering the total nutritional value for ruminants (Mahesh and Mohini, 2013). Moreover, several methods such as physical, chemical, physicochemical, and biological techniques have been developed to enhance the utilization of energy from these cobs due to their improved quality, which can result in degradability and allow ruminal microorganisms to attack the structural carbohydrates and increase hemicellulose and cellulose degradation (Sun *et al.*, 1995; Walli, 2009; Arwinsyah and Yunilas, 2018).

Additionally, several alkalis, including ammonia, sodium hydroxide (NaOH), calcium oxide (CaO), and calcium hydroxide (CaOH₂), have been used to improve the nutritional value of low-quality forages, particularly crop leftovers, by increasing fibre digestion. However, treating corn cob by fermentation using potassium phosphate and sodium bicarbonate may potentially offer a promising solution for proper ruminant usage. The usefulness of sodium (salt group) in improving the digestibility of corn cobs in dairy diets was reported by Escobar (1979) and Soper *et al.* (1977). Therefore, this study aimed to determine the effect of fermentation duration on the nutritive value of treated corn cob flakes.

Materials and Methods

Study location

The experiment was conducted at the Teaching and Research Farm and in the animal nutrition laboratory College of Agricultural Sciences, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. The university campus is located in a deciduous/derived savannah zone

of Nigeria on latitude 7°15'N and longitude 3°3'E. The climate is sub-humid tropical with an annual rainfall of 1,909.3mm. The rainy season is between early April and late October. The rainfall pattern is bimodal with two peaks in June and September. Maximum temperature varies between 29°C during the peak of the wet season and 34°C at the onset of the dry season and mean annual relative humidity is 81% (Onakomaiya *et al.*, 1992).

Sample collection

Maize cobs were obtained from the Crop Production Processing site at the Teaching and Research Farm, College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro, Ogun State. The collection was done during the dry season between October and February during the late maize harvest. The cobs were sun-dried before grinding with a hammer mill (2.5mm screen).

Media preparation

The soft medium (cellulase Fullzyme®) was measured according to the manufacturer's specification in g/l. In the present trial, However, 1.00 g of the soft media (i.e enzyme and salts (potassium phosphate and bi-carbonate of soda) were dissolved in 1litre of water and used to treat (soak) 2 kg of corn cob flakes (solid medium). Each of the mixed feeds was placed in tight polythene bags to remove as much air as possible and placed inside a drum and fermented for 0, 15, 30 and 50 days.

Experimentation

Experimental feedstuff was allotted in an arrangement comprising four fermentation durations (0, 15, 30 and 50 days) with six treatments from a solution made from inorganic salt solution (potassium phosphate/bi-carbonate) and cellulase (Fullzyme® enzyme) which were designated as T0, T1, T2, T3, T4, T5 and T6 in a

completely randomized design experiment. They were designated as follows:

T0 – 1 litre of water per 2 kg of corn cob flakes

T1 – 100% potassium phosphate per litre of water for 2 kg of corn cob flakes

T2 – 50% potassium phosphate + 50% bicarbonate of soda per litre of water for 2 kg of corn cob flakes

T3 – 100% of bi-carbonate of soda per litre for 2 kg of corn cob flakes

T4 – 50% bicarbonate of soda + 50% of cellulase (Fullzyme ®) per litre of water for 2 kg of corn cob flakes

T5 – 50% potassium phosphate + 50% of cellulase (Fullzyme ®) per litre of water for 2 kg of corn cob flakes

T6 – 100% of cellulase (Fullzyme ®) per litre for 2 kg of corn cob flakes

Laboratory analysis and data collection on the nutritive value of treated corn cob

Proximate analysis of the experimental diets

The feedstuff used for the study was analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash, and Nitrogen Free Extract (NFE) (AOAC, 2005).

Phytochemical Analysis

Anti-nutritional factors (tannin, saponin, phytate and oxalate) were determined by using the standard procedure of (Harborne, 1998; Houghton and Raman, 1998).

Statistical analysis

Data were subjected to analysis of variance in a completely randomized design and significant means were separated by Duncan's multiple range tests using the procedure of SAS (2002).

Results and Discussion

The proximate composition of treated corn cob flakes is presented in Table 1. The results of this study showed that treatment only had a significant effect on DM and CP at 50 days of fermentation. Significant treatment effects were also observed at fermentation days of 30 and 50 for CF and EE. With respect to Ash, a non-significant treatment effect was observed only at fermentation day 0 while for NFE, treatment had no effect at all fermentation days. However, the value recorded for 50 days of fermentation across the treatment (T0 to T6) for DM and CP were highest in corn cob treated with enzyme (T6), followed by those corn cob treated with the proportion of 50% cellulase + 50% feed additives (T4 and T5). The least significant ($P < 0.05$) value was recorded for those on T3, T2, T1 and T0 respectively. The corn cob flakes treated with cellulase enzyme (T6) on both 30 and 50 days of fermentation had a significant ($P < 0.05$) reduction in the CF when compared with other treatments. However, mixed cellulase enzyme and feed additives (T4 and T5) slightly followed while the lowest value was obtained for control (corn cob flakes without treatment and fermentation). The value recorded for EE and Ash contents revealed that as fermentation progressed at 30 and 50 days, there was an increase in the value recorded for EE and Ash for corn cob treated with 50% cellulase enzyme + organic salts (potassium phosphorus), followed by those treated 100% cellulase and bicarbonate of soda.

According to the findings of the current study, feed that has been fermented for 30 and 50 days while being treated with different salts and enzymes showed an increase in the composition of dry matter, crude protein, and minerals while decreasing the amount of fiber. This is consistent with the findings of Patel *et al.* (2007) and Verma *et al.* (2011), who reported that pretreatment (which includes fermentation) causes several

biochemical and nutritional changes in raw materials, including the breakdown of specific constituents and changes to cellulosic biomass's structural elements to make them more accessible to the enzymes that convert fibrolytic material into simple carbohydrate polymers. The impact of fermentation with the use of organic salt in the present study corresponds with the findings established by Escobar and Parra (1984), to increase the nutritional value of these materials. Akinfemi

et al. (2009) found that adding salt solutions enhanced the DM content of corn husk. However, the indication that the 50-day fermentation in the current study increased the results for proximate parameters shows that organic salts (potassium phosphate and bicarbonate of soda) with the inclusion of enzyme have entirely dissolved into the flakes and made it easier for existing anaerobic microorganisms to degrade it.

Table 1: Effect of treatment on the proximate composition of corn cob flakes at different fermentation periods

Parameters	Days	Treatments						SEM	
		T0	T1	T2	T3	T4	T5		T6
DM	0	56.43	57.77	62.00	59.00	61.33	59.12	59.55	0.78
	15	54.51	66.18	63.62	63.70	66.56	58.90	66.43	0.83
	30	59.76	67.01	64.33	64.44	67.71	60.06	67.67	0.49
	50	70.10 ^d	72.41 ^c	72.71 ^c	71.09 ^c	74.81 ^b	74.55 ^b	84.44 ^a	0.36
CP	0	2.47	2.07	2.63	2.13	2.63	2.36	2.14	0.02
	15	2.32	2.11	2.25	2.01	2.61	2.07	2.64	0.03
	30	2.53	2.18	2.37	2.60	2.87	2.45	2.89	0.03
	50	2.57 ^c	2.32 ^d	2.41 ^d	2.65 ^c	2.97 ^b	3.01 ^b	3.32 ^a	0.04
CF	0	61.67	65.66	57.00	56.18	55.33	56.67	56.67	0.71
	15	58.00	55.00	54.67	51.00	51.33	53.33	54.00	0.64
	30	53.33 ^a	52.90 ^b	53.33 ^a	50.82 ^c	50.00 ^c	50.21 ^c	49.00 ^d	0.77
	50	52.10 ^a	53.42 ^a	50.01 ^b	50.90 ^b	46.99 ^c	45.11 ^d	44.76 ^d	0.57
EE	0	0.33	0.30	0.33	0.30	0.33	0.20	0.36	0.05
	15	0.37	0.33	0.23	0.27	0.33	0.23	0.27	0.02
	30	0.41 ^c	0.46 ^b	0.39 ^d	0.44 ^b	0.47 ^a	0.49 ^a	0.49 ^a	0.03
	50	0.43 ^c	0.51 ^b	0.49 ^c	0.37 ^d	0.41 ^c	0.51 ^b	0.61 ^a	0.04
Ash	0	0.15	0.19	0.61	0.13	0.11	0.13	0.14	0.02
	15	0.41 ^d	0.53 ^c	0.52 ^c	0.65 ^a	0.56 ^b	0.69 ^a	0.50 ^c	0.03
	30	1.00 ^d	1.67 ^d	1.77 ^c	1.82 ^c	1.88 ^b	1.98 ^a	1.91 ^b	0.03
	50	1.41 ^d	1.81 ^c	2.17 ^a	1.97 ^c	2.04 ^b	2.21 ^a	2.08 ^b	0.04
NFE	0	34.78	31.18	39.73	40.26	41.61	40.24	40.59	0.65
	15	38.40	42.03	42.33	46.07	45.17	43.68	42.59	0.56
	30	42.73	42.79	45.46	44.32	44.79	45.76	45.71	0.65
	50	43.49	41.94	41.60	43.97	44.58	44.14	44.13	0.65

^{abcd} means within rows different superscripts are significantly different ($p < 0.05$)

The values obtained for fibre fractions of corn cob flakes treated with feed additives and cellulase are presented in Table 2. All parameters observed were significantly ($P < 0.05$) different across the treatments except for ADL at 0 day fermentation. The value recorded for NDF at 0, 15, 30 and 50

days of fermentation was highest in descending order of $T0 < T1 < T2 < T3 < T4 < T5 < T6$, respectively. However, the value for ADF followed the same trend for NDF where the highest value was recorded for T0 and the lowest for corn cob flakes treated with 100% enzyme and

50% enzyme mixed with organic salt (T4 and T5). For ADL, the value recorded for 15 days of fermentation was highest ($P<0.05$) in T2 followed by T0 and T1, T3, T4, T5 and T6 had the lowest. Also, for corn cob flakes fermented for 30 days, T1 had the highest value while the lowest value was obtained for T5 and T6. With respect to the 50 days of fermentation, the highest ($P<0.05$) was obtained for T0 and T3, followed by T1, T2 and T3 and lower values were obtained for T4, T5 and T6.

This study showed that fermentation with enzymes and feed additives (sodium bicarbonate and potassium phosphate) has an impact on the fibre percentage of corn cob flake. This was in agreement with the findings of Ashy and Abou-Zeid (2009), which claimed that a combination of

treatments, such as enzymes and other factors, promotes successful fermentation. Sun and Cheng (2002), also reported that treatment of lignocellulosic material with diluted NaOH and other salt-related components caused swelling, increased internal surface area, lowered the degree of polymerisation, increased crystallinity, separating structural linkages between lignin and carbohydrates, and disrupted the structure of the lignin. Additionally, a study by Egounlety and Aworh (2000) and Maurice (2001) found that enzyme alkali treatment helped degrade complex materials and synthesis of B vitamins. This indicated that prolonged fermentation time of up to 50 days and the use of feed additives or enzymes in the study tend to degrade the fibrous molecules present in the corn cob flake.

Table 2. Fibre fractions of corn cob flakes treated with feed additives and cellulose over different fermentation periods

Parameters	Fermentation duration	Treatments							SEM
		T0	T1	T2	T3	T4	T5	T6	
NDF	0	68.33 ^a	66.67 ^{ab}	66.67 ^{ab}	65.00 ^b	64.01 ^{bc}	62.10 ^c	60.60 ^d	0.78
	15	67.13 ^a	65.00 ^{ab}	64.67 ^b	62.33 ^{bc}	62.33 ^{bc}	61.11 ^c	58.00 ^d	0.70
	30	66.25 ^a	60.21 ^c	63.23 ^{ab}	61.00 ^b	61.00 ^b	60.10 ^c	57.05 ^d	0.47
	50	65.00 ^{ab}	59.13 ^b	61.01 ^a	59.30 ^b	58.31 ^c	55.40 ^{cd}	53.20 ^d	0.67
ADF	0	63.00 ^a	63.00 ^a	62.67 ^{ab}	57.00 ^b	55.00 ^c	55.00 ^c	48.76 ^d	0.56
	15	60.51 ^{ab}	61.90 ^a	61.14 ^a	56.24 ^b	54.44 ^c	53.33 ^{cd}	46.56 ^d	0.79
	30	58.88 ^{ab}	59.10 ^a	59.40 ^a	58.50 ^{ab}	57.53 ^c	56.08 ^{cd}	45.10 ^d	0.68
	50	55.04 ^{ab}	56.58 ^a	54.33 ^b	54.80 ^b	53.10 ^{bc}	53.75 ^c	53.71 ^c	0.74
ADL	0	57.00	59.00	56.33	48.71	47.90	46.90	46.00	0.56
	15	56.01 ^{ab}	58.88 ^a	54.44 ^b	47.17 ^c	46.50 ^c	45.29 ^d	45.90 ^d	0.74
	30	55.55 ^a	57.11 ^{ab}	54.00 ^b	46.90 ^b	45.20 ^b	44.44 ^c	43.93 ^d	0.79
	50	52.13 ^a	52.54 ^a	52.07 ^a	45.12 ^b	42.84 ^{bc}	40.10 ^c	39.02 ^d	0.81

^{abcd} means within rows different superscripts are significantly different ($p<0.05$)

The values of phytochemical profile of corn cob flakes treated with feed additives and

cellulase are presented in Table 3. It was recorded that values for saponin and

flavonoid were significantly ($P<0.05$) influenced treatment at all the fermentation days. However, the values recorded for saponin and flavonoid were higher at 0 day of fermentation with gradual reduction as days of fermentation progressed.

In the current study, it was recorded that the use of fermentation frequently had an impact on corn cob flake that has been treated with either potassium phosphate, sodium bicarbonate or enzyme. This was in line with the assertion of Marfo *et al.* (1990) that the fermentation process has a tendency to lower crop residual phytochemical levels. This was

also consistent with the results of Olagunju *et al.* (2013), who found that applying fermentation to maize cobs resulted in a considerable reduction in saponin, oxalate, and phytate. However, Adeniran *et al.* (2013) in their study found that combining physical and chemical processes with enzymes to increase the nutritional content of maize cobs can be very advantageous. Additionally, Opere *et al.* (2012) revealed that fermentation increased protein content, reduced sugar content and antinutritional factors (phytates, tannins, and polyphenols), and improved the bioavailability of minerals.

Table 3: Phytochemical profile of corn cob flakes treated with feed additives and cellulose and cellulose at different days of fermentation

Parameters	Days	Treatments								SEM
		T0	T1	T2	T3	T4	T5	T6		
Saponin	0	93.61 ^a	88.71 ^{ab}	86.34 ^b	84.45 ^{bc}	84.41 ^{bc}	81.22 ^c	74.80 ^d	0.64	
	15	91.01 ^a	86.41 ^{ab}	83.33 ^b	81.90 ^{bc}	80.70 ^c	76.80 ^{cd}	72.11 ^d	0.47	
	30	87.80 ^a	84.21 ^{ab}	81.00 ^b	78.42 ^{bc}	78.00 ^{bc}	75.90 ^c	70.11 ^d	0.59	
	50	86.00 ^a	81.00 ^{ab}	79.21 ^b	75.37 ^{bc}	73.33 ^c	71.10 ^{cd}	68.00 ^d	0.06	
Tannin	0	1.90	1.81	1.81	1.62	1.51	1.51	1.44	0.01	
	15	1.78	1.67	1.65	1.60	1.48	1.44	1.41	0.02	
	30	1.88 ^a	1.77 ^b	1.78 ^b	1.51 ^c	1.46 ^d	1.42 ^d	1.40 ^d	0.03	
	50	1.71 ^a	1.72 ^a	1.69 ^{ab}	1.31 ^b	1.12 ^c	1.09 ^d	1.09 ^d	0.02	
Flavonoid	0	96.81 ^a	89.61 ^{ab}	88.82 ^{ab}	81.67 ^b	80.81 ^{bc}	78.81 ^c	76.81 ^d	0.33	
	15	93.33 ^a	86.81 ^{ab}	84.02 ^b	78.90 ^{bc}	78.00 ^{bc}	75.38 ^c	75.40 ^d	0.32	
	30	90.00 ^a	85.55 ^{ab}	82.10 ^b	74.44 ^{bc}	74.02 ^{bc}	73.48 ^c	73.20 ^d	0.33	
	50	88.97 ^a	83.22 ^{ab}	80.10 ^b	71.53 ^{bc}	69.80 ^c	65.67 ^{cd}	63.90 ^d	0.30	
Phytate	0	0.28	0.26	0.25	0.23	0.23	0.23	0.22	0.02	
	15	0.27	0.26	0.23	0.21	0.22	0.22	0.21	0.02	
	30	0.27	0.25	0.24	0.21	0.19	0.20	0.21	0.02	
	50	0.26 ^a	0.22 ^{ab}	0.20 ^b	0.20 ^b	0.17 ^c	0.15 ^d	0.15 ^d	0.02	

^{abcd} means within rows different superscripts are significantly different ($p<0.05$)

Conclusion and Recommendation

The results obtained in the present study, revealed that treating corn cob with 50% feed additives (either sodium bicarbonate or potassium phosphate) with enzyme and fermenting for up to 50 days tends to improve the proximate composition, reduced fibre fractions and phytochemical properties. It is therefore recommended that corn cob be treated with cellulase enzyme up to 50% and fermented before feeding to ruminants.

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