Effect of mimosa diplotricha leaf meal on the organ weights and organoleptic properties of three broiler strains

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Effect of *mimosa diplotricha leaf meal* on the organ weights and organoleptic properties of three broiler strains

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Abstract

The effect of Mimosa diplotricha leaf meal (MDLM) on the organ weights and organoleptic properties of three broiler breeds was studied using 120 day-old chicks reared for eight weeks. The work was carried out using randomized complete block design. The breeds namely Arbo Acre, Cobbs and Ross were designated as treatment 1, 2 and 3, respectively with three replicates each. Two diet groups; diet with 2% Mimosa diplotricha leaf meal and diets without the leaf meal were administered. The organ weights and organoleptic properties of the broiler strains were determined. Mimosa diplotricha had no significant effect on the heart, spleen, gizzard and liver weights of the birds. Furthermore, similar spleen weights were obtained across the breeds, while discrepancies were observed in heart, gizzard and liver weights of the breeds. Cobbs best tolerated the leaf meal with respect to organ weights and gave the best taste, flavor intensity and desirability. Results showed that Mimosa diplotricha could be used as a partial replacement of wheat offal in broiler diets. However, lesser concentration may be used for Ross breed. Regardless of feed inclusion, Cobbs is observed as the best breed in comparison to Arbo acre and Ross broilers with respect to organoleptic properties and organ weights.

Keywords: breeds, Mimosa, organ weights, organoleptic

Introduction

The poultry industry has long been at the mercy of poultry feed manufacturers. Many livestock farmers have opted out of the industry following the unbearable prices of feeds, yet, many more have plunged in with enough capital to handle production from start to finish, managing the little profit they can gather. Most production cost estimates range from 60% to 70% as being feed costs (Behnke and Beyer, 1994) but more recent is its increase to over 70% as pointed out by Matthew and Moji (2008). High cost of feed is largely dependent on the availability of feed ingredients which in turn affects the quality of feeds as feed manufacturers do not meet up with certain necessary inputs. Not to be forgotten is the rapid growth of human and livestock population which while creating an increased food and feed requirement in the less developed countries, demand that alternative feed resources be identified and evaluated as stated by Odunsi (2003). The reason behind feed cost rising is the type and concentration of protein supplementation with poultry diets (Nworgu, 2015). Okah and Onwujiariri (2012) reported that any efforts towards reducing the cost of protein sources will decrease the poultry production cost and livestock cost in general. These efforts should not only aim at reduction of protein costs but provision of high quality protein. Quality protein determines the efficiency of feed utilization.

As D'Souza (2007) states, the poultry industry will have to look to history for the feed solutions of the future. A promising alternative to conventional protein sources is the leaf meal of some legumes and browse plants (Esonu *et al*., 2003). Ravindran (1992) noted that leaf meals provide not only proteins but vitamins and minerals.

The suitability and efficiency of these leaf meals is monitored by changes in organ characteristics like organ weights and organoleptic properties of test animals. Such changes in organ characteristics could be favourable or detrimental to the animals, thereby determining whether or not the leaf meal is suitable. Organoleptic properties are the traits which determine the regular purchase and consumption of meat by consumers (Amao *et al*., 2015); meat with little or no attraction to consumers is most likely to be bullied out of the market. Breed plays an important role in the nutrient quality requirement of a diet and remains one of the major factors that affect the consumption and utilization of feedstuff. Specificity of each breed tells how well the bird utilizes feed and is able to meet consumer standards.

A largely available leguminous plant having great potential is the *Mimosa diplotricha*, formerly known as *Mimosa invisa* (Anon, 2001). *Mimosa diplotricha* is a biennial or perennial legume (Holm *et al*., 1977) which starts as an erect plant and grows into a spiny climbing shrub with the capacity to smother competing plants in its domain (Alabi *et al*., 2001). It belongs to the genus *Mimosa*, in the legume family *Fabaceae* or *Mimosaceae*. Laboratory analyses have shown that the protein concentration of *Mimosa diplotricha* leaf meal is 23.34% (Nworgu and Egbunike, 2013). *Mimosa diplotricha* leaf meal is a potential source of protein in broiler diet which has majorly been untapped and could help overcome cost challenge due to its cheap availability and impressive protein percentage.

Chinelo *et al*. (2016) studied the nutritive value of the different morphological components of *Mimosa diplotricha*. She found its leaves to contain a higher concentration of carbohydrates, ash and fat in relation to its stem and root. *Mimosa diplotricha* has also been compared with its sister specie, *Mimosa pudica* and found to be of higher protein content. There is dearth of research report on its use as a feed ingredient in the broiler production. Consequently, the study was designed to ascertain the effect of *Mimosa diplotricha leaf meal* on the organ weights and organoleptic properties of three major broiler strains in Nigeria.

Materials and methods

Experimental site

The research was undertaken at the poultry house of the Department of Animal Science and Technology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Awka is the Capital of Anambra State and it is in the tropical rainfall zone of Nigeria. The mean annual temperature, rainfall and humidity are 27.0°C, 1828 and 80% respectively. The driest month is December with a rainfall of 7mm and the highest is September having an average of 306 mm. Rainy season lasts for six months, occurring from April to July and September and October. It is located within the latitude, $6^0$12'25"N and longitude, 7^0 04'04"E.

Sources and processing of Mimosa diplotricha leaf meal

Mimosa diplotricha leaves were harvested green around the Faculty of Agriculture, Nnamdi Azikiwe University, Awka within the months of January, February and March. They were harvested by plucking manually the stems of the plant consisting of its leaves and spreading for 3 days to dry. The dried, crispy, green leaves were then dusted out of the stems and sieved to ensure proper removal of its stems. Given the small sizes of the leaves, grinding was not done. They were packaged in air-tight sacs for subsequent use.

Feeding trial

Experimental diets

The feeding trial was carried out in two phases: the starter phase and the finisher phase. Two starter diets were formulated; diet 1 with no mimosa inclusion as the control diet and diet 2 with 2% MDLM, in partial replacement of wheat offal. The finisher diet was adjusted to suit the required broiler finisher phase of lesser protein and higher carbohydrates. The ingredient compositions of both diets are shown in Tables 1 and 2, respectively.

Table 1: Composition of the starter diet

Ingredients	***Mimosa diplotricha* Inclusion**	
	0%	2%
Maize	50.00	50.00
Soybean Meal	30.00	30.00
Mimosa diplotricha leaf meal	0.00	2.00
Wheat Offal	8.00	6.00
Fish meal	2.00	2.00
Blood meal	2.00	2.00
Palm kernel cake	4.00	4.00
Bone meal	3.00	3.00
Salt	0.25	0.25
Lysine	0.25	0.25
Methionine	0.25	0.25
*Mineral/vitamin premix	0.25	0.25
Calculated analysis		
Crude protein (%)	22.46	22.48

***to provide Vit A; 10,000,00iu, Vit D3; 2,000,00iu,Vit E; 10,000iu, Vit K; 2500mg, Vit B1; 2000mg, Vit B2; 70,000mg, Vit B6; 2000mg, Niacin; 50,000mg, Vit B12; 15mg, Pantothenic; 5000mg, Folic Acid; 750mg, Choline Chloride; 400gr, BHT; 125gr, Manganese; 10gr,Zinc; 100gr, Iron; 30gr, Copper; 10gr, Iodine; 1.5gr, Selenium; 200mgr, Cobalt; 20 0mgr, Lysine; 15gr, Methionine; 20gr, Biotin; 100mgr.**

Table 2: Composition of the finisher diet

Ingredients	***Mimosa diplotricha* Inclusion**	
	0%	2%
Maize	60.00	60.00
Soybean meal	20.00	20.00
Mimosa diplotricha leaf meal	0.00	2.00
Wheat Offal	8.00	6.00
Fish meal	2.00	2.00
Blood meal	2.00	2.00
Palm kernel cake	4.00	4.00
Bone meal	3.00	3.00
Salt	0.25	0.25
Lysine	0.25	0.25
Methionine	0.25	0.25
*Mineral/vitamin premix	0.25	0.25
Calculated analysis		
Crude protein (%)	18.95	18.97

***to provide Vit A; 10, 000,00iu, Vit D3; 2,000,00iu,Vit E; 10,000iu, Vit K; 2500mg, Vit B1; 2000mg, Vit B2; 70,000mg, Vit B6; 2000mg, Niacin; 50,000mg, Vit B12; 15mg, Pantothenic; 5000mg, Folic Acid; 750mg, Choline Chloride; 400gr, BHT; 125gr, Manganese; 10gr,Zinc; 100gr, Iron; 30gr, Copper; 10gr, Iodine; 1.5gr, Selenium; 200mgr, Cobalt; 200mgr, Lysine; 15gr, Methionine; 20gr, Biotin; 100mgr.**

The proximate composition of *Mimosa diplotricha* leaf meal as given by Nworgu & Egbunike (2013) is shown in Table 3.

Table 3: Proximate analysis of *Mimosa diplotricha* leaf meal

Fraction (%)	*Mimosa diplotricha* leaf meal
Dry Matter	89.99
Crude Protein	23.34
Crude Fiber	11.29
Ether Extract	2.38
Ash	4.25
Nitrogen Free Extract (NFE)	58.74

Source: Nworgu and Egbunike (2013)

Experimental birds

One hundred and twenty day-old broiler chicks of the breeds were used to carry out this experiment. It was made of forty birds each for the Arbo Acre, Cobbs and Ross broiler breeds. They were purchased from Zartech Farms, Ibadan, Oyo State. The chicks were fed commercial broiler starter for two weeks. Brooding was done with the chicks in four groups of thirty and adequate heat provided. Light was set out at night for enhanced growth. At the end of two weeks, the birds were placed in three groups representing the three broiler breeds. Each group was separated in two with one half being fed on diet 1 and the other half on diet 2. The birds were fed their respective experimental diets once a day. Routine medications and antibiotics were administered.

By the end of the starter phase, the finisher experimental diet was given to the birds as in the starter phase.

Data collection

Organ weights

At the 8^{th} week, data were collected on organ weights of eighteen experimental birds. Three birds each were selected from the two diets in each breed. The birds were slaughtered according to the Modified Kosher method of poultry slaughter and allowed to bleed for 90 seconds to prevent discoloration of the cooked meat. The slaughtered birds were scalded in hot water for easy de-feathering and the visceral organs were extracted. The heart, liver, gizzard, lung and kidneys were taken out and placed in a previously washed bowl to avoid contamination and for subsequent weighing. These organs were weighed using a sensitive electronic scale.

Organoleptic properties

Samples were collected from the breast of the experimental birds and cut into 50g sizes. They were cooked for 5 minutes with 5g of salt and placed in small insulated coolers to maintain temperature. The coolers were in turn put in a bigger cooler for further temperature control. The samples were then served to 11 panelists comprising staff and students of Nnamdi Azikiwe University, Awka. The panelists assessed the juiciness, taste, texture, flavor intensity and desirability of each sample using a questionnaire (See Appendix I). The assessment was done using a 5-point Hedonic scale as described by Barylko-Pikielna (1975) with 1 being the least favourable of each parameter and 6 being its best condition.

Statistical analysis

Data for organ weights were subjected to a two-way analysis of variance test using GENSTAT release 7.2 Statistical Software. The means were separated using the Least Significant Difference (LSD) Test. Data for organoleptic characteristics were subjected to a two-way analysis of variance test using

SPSS version 22 Statistical Package. The means were separated using the Duncan New Multiple Range Test as outlined by Duncan (1955).

Results

Effects of Mimosa diplotricha inclusion on the organ weights of broilers

The effects of *Mimosa diplotricha* inclusion on the organ weights of broilers are presented in Table 4. Regardless of breed, inclusion of *Mimosa diplotricha* leaf meal had no significant effect ($p>0.05$) on the weights of the heart, spleen, gizzard and liver of broiler birds placed on such diet although this was not the case for the weight of the intestine. There was a significant ($p<0.05$) difference in the consumption of *Mimosa diplotricha* on the intestine weight of the birds with a value of 110.4 and 126.9 for 0% and 2% inclusion, respectively. Figure 1 is a bar chart comparing 0% and 2% MDLM inclusion levels on various organ weights of broilers.

Table 4: Effects of *Mimosa diplotricha* inclusion on the organ weights of broilers

Organs	Inclusion Levels		
	0%	2%	$LSD_{0.05}$
Heart	9.22 ± 0.192	8.78 ± 0.192	Ns
Spleen	1.67 ± 0.157	1.78 ± 0.157	Ns
Gizzard	48.70 ± 1.856	45.20 ± 1.856	Ns
Liver	37.00 ± 1.558	36.70 ± 1.558	Ns
Full Intestine	110.40 ± 4.734	126.90 ± 4.734	14.590

ns =not significant **All values are in grams**

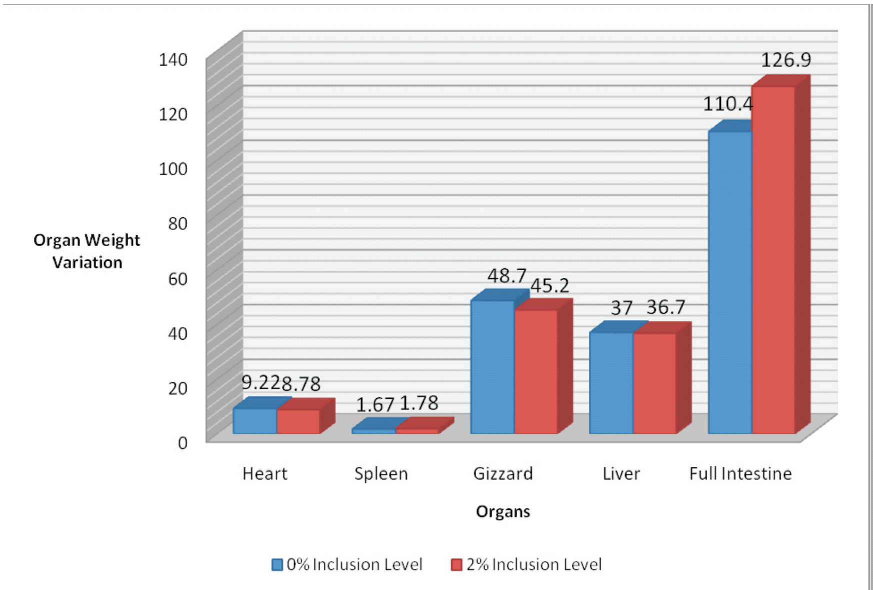

Figure 1: Effects of *Mimosa* inclusion levels on the organ weights of broilers

Effects of breeds on the organ weights of broilers

The effects of breeds on the organ weights of broilers are shown in Table 5 and Figure 2 showed the variation in bar chart. Arbo acre showed a significant ($p<0.05$) lower heart weight than Cobbs and Ross broilers. There were no significant differences ($p>0.05$) on the spleen weights of all the experimental breeds. Significant difference was observed in the gizzard weights of Cobbs and Ross breeds and Arbo acre and

Ross breeds, whereas non-significant variations were observed in the gizzard weights of Arbo acre and Cobbs breeds. Ross broiler was seen to be significantly higher in the gizzard weight.
Similar occurrence is seen in the weights of the liver and intestine.

Table 5: Effects of breeds on the organ weights of broilers

Organs	Breeds			
	Arbo acre	Cobbs	Ross	$LSD_{0.05}$
Heart	8.33 ± 0.236	9.33 ± 0.236	9.33 ± 0.236	0.726
Spleen	1.67 ± 0.192	1.83 ± 0.192	1.67 ± 0.192	Ns
Gizzard	41.30 ± 2.273	43.30 ± 2.273	56.20 ± 2.273	7.000
Liver	33.00 ± 1.908	35.00 ± 1.908	42.50 ± 1.908	5.880
Intestine	112.70 ± 5.798	102.30 ± 5.798	141.00 ± 5.798	17.860

ns =no significant difference

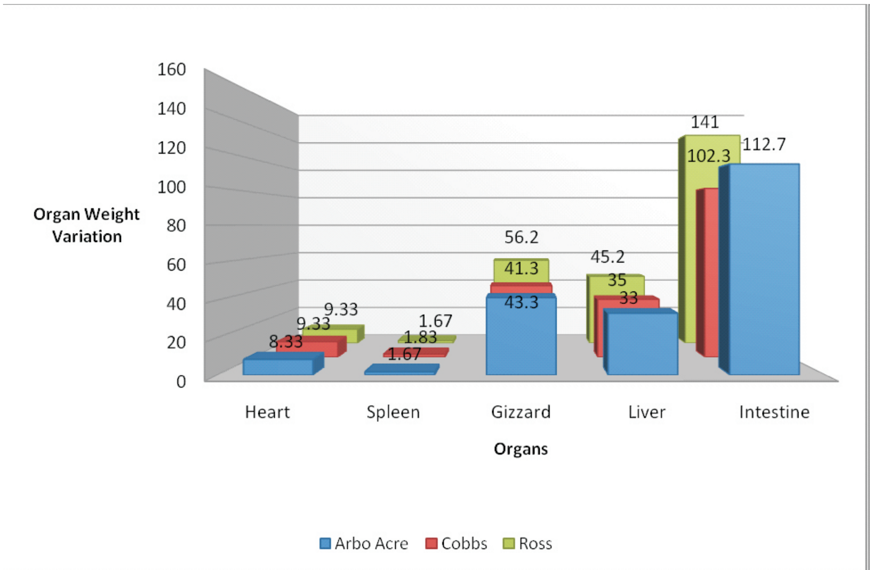

Figure 2: Effects of breeds on the organ weights of broilers

Interaction of breeds and feed inclusion on the organ weights of broilers

The interaction between breeds and MDLM inclusion on the organ weights of broilers are presented in Table 6 and represented in a sketch in Figure 3. *Mimosa diplotricha* leaf meal administered to Cobbs and Ross breeds significantly affected the heart weight of the breeds but had non-significant effect on the heart weight of Arbo acre broiler breed.

There was non-significant interaction observed between feed inclusion and breeds with respect to the spleen weight. The gizzard and liver weights were affected by all the breeds' consumption of *Mimosa diplotricha* leaf meal. Ross broiler breed had a significant effect with respect to weight of intestine when fed the leaf meal as against Arbo acre and Cobbs broilers which were not affected by Mimosa consumption.

Table 6: Interaction of breeds and inclusion on the organ weights of broilers

Breeds	Feed Inclusion (%)	Organs				
		Heart	**Spleen**	**Gizzard**	**Liver**	**Full Intestine**
Arbo acre	0	8.00±0.333	1.67±0.272	45.00±3.215	36.00±2.698	113.70±8.199
	2	8.67±0.333	1.67±0.272	37.70±3.215	30.00±2.698	111.70±8.199
Cobbs	0	11.00±0.333	2.00±0.272	42.00±3.215	34.00±2.698	103.70±8.199
	2	7.67±0.333	1.67±0.272	44.70±3.215	36.00±2.698	101.00±8.199
Ross	0	8.67±0.333	1.33±0.272	59.00±3.215	41.00±2.698	114.00±8.199
	2	10.00±0.333	2.00±0.272	53.30±3.215	44.00±2.698	168.00±8.199
$LSD_{0.05}$		1.027	Ns	9.910	8.310	25.260

ns =not significant All values are in grams

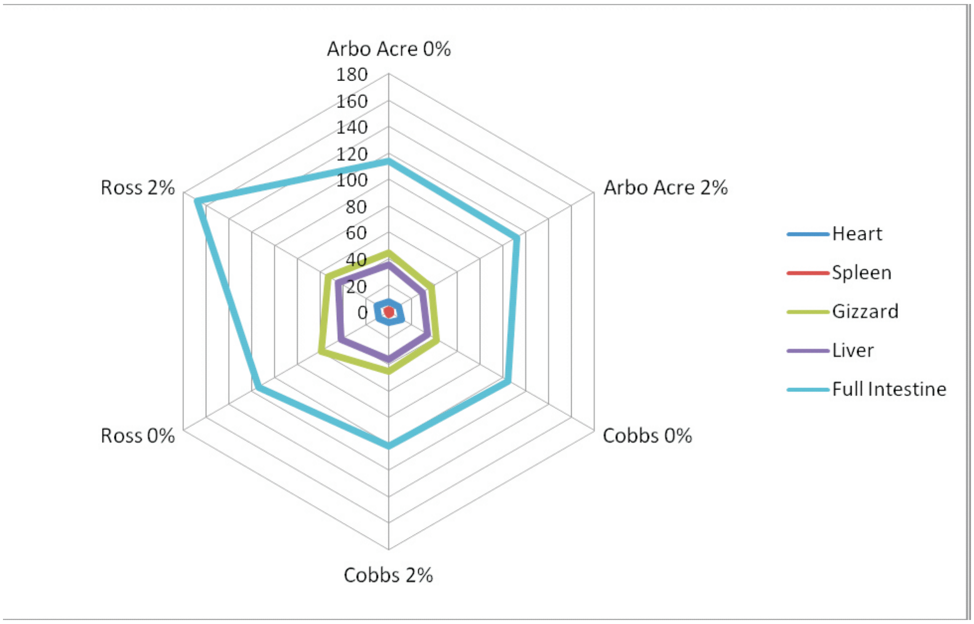

Figure 3: Interaction of breeds and MDLM inclusion on the organ weights of Broilers

Effects of MDLM inclusion and breed on the organoleptic properties of broilers

The effects of *Mimosa diplotricha* leaf meal (MDLM) inclusion on the organoleptic properties of three broiler breeds are given in Table 7 and in bar chart 4. Juiciness and Tenderness are seen to be significantly not affected by the inclusion of MDLM and breed of the broilers. Arbo acre fed 2% MDLM is observed to be significantly different from its 0% inclusion and from Cobbs and Ross. Flavour Intensity and Desirability are similar for all breeds and inclusions.

Table 7: Effects of *Mimosa diplotricha* inclusion and breeds on the organoleptic properties of broilers

	Breeds/Inclusion levels					
	Arbo acre		**Cobbs**		**Ross**	
Parameters	**0%**	**2%**	**0%**	**2%**	**0%**	**2%**
Juiciness	4.27±0.09^{a}	3.86±0.59^{a}	4.09±0.36^{a}	4.09±0.27^{a}	4.05±0.05^{a}	3.41±0.23^{a}
Tenderness	3.64±0.36^{a}	4.32±0.05^{a}	3.68±0.68^{a}	3.45±0.09^{a}	3.59±0.14^{a}	3.18±0.36^{a}
Taste	4.22±0.14^{ab}	3.77±0.23^{a}	4.32±0.14^{b}	4.41±0.05^{b}	3.95±0.05^{ab}	3.95±0.05^{ab}
Flavour Intensity	3.50±0.14^{a}	3.41±0.59^{a}	3.55±0.18^{a}	3.68±0.14^{a}	3.09±0.00^{a}	3.14±0.05^{a}
Desirability	3.86±0.05^{a}	3.64±0.55^{a}	3.77±0.14^{a}	3.91±0.09^{a}	3.32±0.41^{a}	3.18±0.09^{a}

[a,b] Means in the same row bearing different superscripts are significantly different ($P < 0.05$)

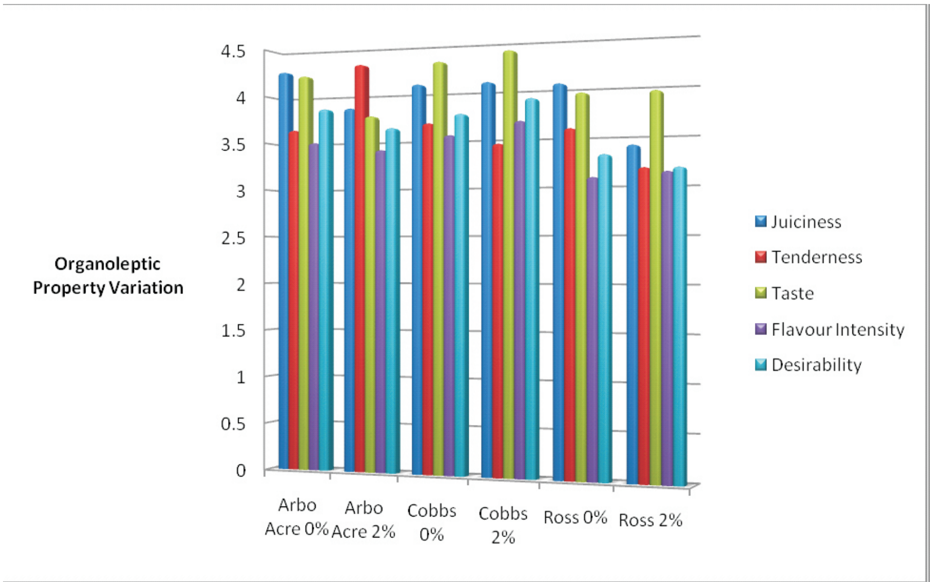

Figure 4: Effects of *Mimosa diplotricha* inclusion and breeds on the organoleptic properties of broilers

Discussion

Effects of Mimosa diplotricha inclusion and breeds on the organ weights of broilers

On the similarity in the weights of the heart, spleen, empty gizzard and liver, Table 4 showed that the inclusion of *Mimosa diplotricha* had no effect on these organs, irrespective of the breed. Olowu *et al.* (2013) and Ayo-Ajasa *et al.* (2016) reported a similar result while working with Neem leaf meal and *Moringa oleifera* leaf meal respectively. This study also supports González-Alvarado *et al.* (2007); Martinez *et al.* (2015) who observed no differences on spleen weight in broilers on high-fibre diets. The result of this study is at variance with Agbabiaka *et al.* (2012) who claimed that consumption of high fibre diet causes an increase in gizzard weight. This shows that the fibre content is not too high as to cause an increase in the gizzard weight.

The increased weight of the full intestine upon consumption of MDLM could be attributed to slower digestibility leading to increased retention of the digesta in the intestine. This is in line with Meremikwu *et al.* (2013), Svihus (2011) and Diarra *et al.*

(2014) who noted that consumption of high fibre diets resulted in increased digesta retention. Cross (2004) also reported that broilers fed diets containing mimosa showed decreased digestibility of amino acids. She attributed this to the presence of one or more phenolic compounds.

Reduced digestibility decreases feed intake which in turn leads to overall poor performance of the birds. The insignificant decrease in organ weights in this study shows the tendency of Mimosa inclusion to reduce broiler performance as these weights are determined by the weight of the birds (Tuleun and Igba, 2007).

Significant effect of breeds on the heart, gizzard and liver weights irrespective of diet, correlates with Taha *et al*. (2010) who in their study with Shaver A, B, C, Salam and Mandarah broiler strains, reported a significant effect of breed on these weights. Fernandes *et al*. (2013) reported a significant difference between Cobb 500 Slow, Cobb Fast, Ross 308, Ross 508, Hybro Plus and Avian 48 broilers. In the present study, Arbo acre was observed to have a significantly lower heart weight and Ross, significantly higher gizzard and liver weights. It does not agree with Olawumi and Fagbuaro (2011) as they noted no significant effect of breed on gizzard and liver weights with Arbo acre (43.8 and 39.6 respectively), Hubbard and Marshall broiler breeds. It also opposes Dariusz *et al*. (2013) whose study on Ross 308, Hubbard Flex and Hubbard F15 observed no significant effect of breeds on these weights with the liver, heart, gizzard and spleen weights of Ross broiler as 43.6, 9.6, 24.7 and 2.7 respectively. Ross is observed to have a higher liver weight than Cobbs and Arbo acre but this does not conform to Kow *et al*. (2015) and Andrea *et al*. (2005) as they report Cobbs as having a higher liver weight (85) than Ross (70).

Johnson and McNab (1983) reported that muscular activity of the gizzard in grinding feed particles determines its size. Ross broiler has the highest gizzard weight and is hence, capable of more efficient feed grinding than Arbo Acre and Cobbs. The liver which was also significantly higher in this breed is more efficient in its action of detoxification in comparison with other breeds in the present study. Cobbs was observed to have the highest spleen weight, giving an adept immune function than Arbo Acre and Ross as the spleen is known to be a part of the immune system. Ross is shown to have higher intestine weight than Cobbs and Arbo acre broilers.

Significant interaction of Breed and Feed Inclusion affected the weights of the heart, gizzard, liver and full intestine of the birds, corresponding with Olawumi and Fagbuaro (2011) who gave same results in his study with Arbo acre, Hubbard and Marshall broilers.

An increased liver weight of Cobbs and Ross broilers may be attributed to residual toxicity of the *Mimosa diplotricha* leaf meal included. Sun-drying of the leaves may not have eliminated the toxicity of the plant completely. Ross particularly showed a significant increase in heart weight. The heart supports the liver in detoxification and this together with the higher liver weight, revealed the unacceptability of the leaf meal with the breed. The heart weight of Arbo acre was not affected by this breed's consumption of the leaf meal.

A decrease was rather seen in the liver, gizzard and intestine weights of Arbo acre. This decrease showed the poor performance of this breed as a result of *Mimosa diplotricha* inclusion. The spleen weight of all breeds was not affected by the leaf meal consumed, thereby implying that the quantity of *Mimosa diplotricha* leaf meal included was too small to have an effect on the immune system of the broilers. Ross broiler showed significant increase in its full intestine weight with Mimosa inclusion. This signifies longer retention of digesta in this breed.

Effects of Mimosa diplotricha inclusion and breeds on the organoleptic properties of broilers

Ross was observed to be the toughest in diets with no Mimosa inclusion and 2% inclusion, respectively although all breeds are significantly similar in tenderness. This concurs with Abdullah *et al*. (2010) who studied the Lohman, Hubbard JV, Hubbard classic and Ross breeds and reported Ross as a tough broiler breed. This breed is also observed to be the poorest with respect to juiciness, flavor intensity and desirability.

Consumption of *Mimosa diplotricha* reduced the juiciness of Arbo acre and Ross broilers but had no effect on that of Cobbs broilers. It also resulted in a decrease in tenderness in Cobbs and Ross broilers although this was but a slight decrease in Cobbs. Arbo acre fed the leaf meal had the poorest taste but an improvement in taste was observed in Cobbs fed *Mimosa diplotricha*. Regardless of the feed consumed, Cobbs was observed to be most preferred with respect to tenderness, taste and flavor Intensity. Cobbs broiler upon consumption of *Mimosa diplotricha* leaf meal, remained most preferred in terms of taste, flavor intensity and in addition, juiciness and desirability.

Conclusion

The use of 2% *Mimosa diplotricha* leaf meal is suitable in broiler diets given that it had no apparent effect on the weight of organs of broilers in this study. Cobbs was observed to be more tender and have better taste than other breeds with and without the leaf meal inclusion. From a commercial standpoint, this inclusion enables feed cost reduction and higher consumer preference

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