Archivos de Zootecnia
Journal website: https://www.uco.es/ucopress/az/index.php/az/

Effect of neem leaf meal on carcass characteristics and meat quality of broiler chickens

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Additional keywords

Azadirchata indica.
Broiler breast.
Sensory quality.
Cooking and refrigeration losses.

SUMMARY

A study was carried out to assess phytobiotic effect of neem leaf on carcass quality, chemical composition, refrigeration and cooking weight losses of the breast meat of broiler chicken fed varying inclusion levels of neem (*Azadirachta indica*) leaf meal (NLM) at 0, 0.5, 1.0 and 1.5% inclusion levels to replace wheat offal w/w. One hundred and ninety-two birds were divided into four treatments consisting of three replicates and each replicate consisting of 18 birds. The birds were fed ad libitum for 8 weeks. The data obtained were subjected to one-way Analysis of Variance at 95% significant level. The result on carcass weight of broiler chicken fed varying level of neem leaf meal showed no significant (P>0.05) differences in all the parameters. The refrigeration and cooking weight losses, sensory analysis (colour, juiciness, meat flavour, tenderness, flavour, saltiness, overall flavour and overall acceptability) were not influenced by NLM. Moisture and ash contents were the parameters that were significantly (p<0.05) influenced in the meat proximate composition. Ash content increased with increased level of NLM. It was concluded that neem leaf meal up to 1.5% can be included in the diet of broiler chickens as a replacement for wheat offal competed with antibiotics to produce similar results on the carcass and meat quality.

Palabras clave adicionales

Azadirchata indica.
Pechuga de pollo de engorde.
Calidad sensorial.
Pérdidas de cocción y refrigeración.

Efecto de la harina de hoja de neem sobre las características de la canal y la calidad de la carne de los pollos de engorde

RESUMEN

Se llevó a cabo un estudio para evaluar el efecto fitobiótico de la hoja de neem sobre la calidad de la canal, la composición química, la refrigeración y las pérdidas de peso de cocción de la carne de pechuga de pollo de engorde alimentado con niveles variables de inclusión de hoja de neem (*Azadirachta indica*) (NLM) a 0, 0,5, 1,0 y 1,5% niveles de inclusión para reemplazar los despojos de trigo w /w. Ciento noventa y dos aves se dividieron en cuatro tratamientos que consistían en tres réplicas y cada una de las tres réplicas que consisten en 18 aves. Las aves fueron alimentadas *ad libitum* durante 8 semanas. Los datos obtenidos fueron sometidos a un análisis unidireccional de la varianza a un nivel significativo del 95%. El resultado en el peso en canal de pollo de engorde alimentado en diferentes niveles de harina de hoja de neem no mostró diferencias significativas (P>0.05) en todos los parámetros. Las pérdidas de peso de refrigeración y cocción, el análisis sensorial (color, jugosidad, sabor de carne, ternura, sabor, salinidad, sabor general y aceptabilidad general) no fueron influenciados por NLM. El contenido de humedad y cenizas fueron los parámetros que fueron significativamente (P<0.05) influenciados en la composición proxima de la carne. El contenido de cenizas aumentó con un mayor nivel de NLM. Se llegó a la conclusión de que la harina de hoja de neem de hasta el 1,5% puede incluirse en la dieta de pollos de engorde como sustituto de los despojos de trigo compitidos con antibióticos para producir resultados similares sobre la canal y la calidad de la carne.

Information

Cronología del artículo.
Recibido/Received: 07.09.2018
Aceptado/Accepted: 17.10.2018
On-line: 15.01.2020
Correspondencia a los autores/Contact e-mail:
egbeyalelt@funaab.edu.ng

INTRODUCTION

The increase in pathogenic microorganisms in livestock production is one of the major challenges affecting poultry farmers to meet the demand of consumers' (Ifeanyi and Bratte 2015, p. 37). In attempt to over the challenge, antibiotics are commonly used in livestock production but its subsequently residues may persist in foods derived from animals, which may pose adverse health effects for the consumer (Riviere and Papich, 2013, p. 1431; Chanda *et al.* 2014, p. 489). The use of antimicrobial agents as growth promoters are being discouraged due to human and animal health issues mainly resulting from development of antimicrobial resistance (Castanon, 2007, p. 2466). Human exposure to significant levels of antibiotic residues from animal products may aggravate immunological responses in susceptible individuals and negatively

affect intestinal microbiota (Normanno *et al.* 2007, p. 290). Babapour *et al.* (2012, p. 1417) reported that the presence of antibiotics in human food is associated with several adverse public health effects, including hypersensitivity, gastrointestinal disturbance, tissue damage, and neurological disorders.

Therefore, researchers had been on their heels in search for cheap and naturally occurring resources in ensuring the safety of humans and feed stuffs for animals without obstructing the ecosystem. This has attracted a lot of researchers to investigate into several non-conventional plants and their extracts with high antimicrobial properties to reduce microbial infections from farm animals (Yang *et al*. 2014, p. 133; Hanczakowska *et al*. 2015, p. 61).

It has been reported that the addition of neem (*Azadirachta indica*) leaf meal serves as a possible replacement for synthetic antibiotic growth promoters (Ifeanyi and Bratte, 2015, p. 37), help to reduce feed cost and reduce competition between man and the livestock industry for the available conventional feedstuffs (Muriu *et al*., 2002).

Various parts of the tree have been reported to contain chemicals like azadirachtin, nimbin, nimbindin, quercetin and so on (Makeri *et al*. 2007, p. 2306) which have antifungal, antiprotozoa, insecticidal, and spermicidal (SaiRam *et al*. 2000, p. 379) properties which are of great importance and helps in minimizing the cost of feed production and health maintenance in the production of poultry birds.

The paucity of information on the effect of neem leaf meal on carcass and meat quality characteristics of broiler chicken facilitated this study.

MATERIALS AND METHODS

Site of the Experiment

The experiment was carried out at the poultry unit of the Directorate of University farm, Federal University of Agriculture Abeokuta, Nigeria. The site is 76m above the sea level and falls within latitude 7^0 15′N and longitude 3^0 21′E. The climate is an interphase between tropical rain forest and the derived savannah vegetation zone of South Western Nigeria. It receives a mean precipitation of 1037mm with annual temperature of 34.7^{0}C Relative humidity averages of 82%.

Preparation of test ingredient

Leaves of *Azadiractha indica* were harvested and air dried for seven days and milled together with concentrate feed at varying levels of 0, 0.5, 1.0 and 1.5% to replace wheat offal (w/w) in the broiler's diet.

Experimental birds and management

A total of 192 day-old broiler chicks was purchased from a reputable commercial hatchery in Abeokuta in Ogun State. The birds were divided into 4 treatments groups of 48 birds per treatment. Each group was further sub-divided into 3 replicates of 16 birds each. Birds in treatment A serves as the control (without neem leaf). Birds in treatment B were fed with feed with inclusion level of 0.5% of neem leaf, birds in treatment C were fed diet with inclusion level of 1.0% of neem leaf while birds in treatment D were fed with diet with inclusion level of 1.5% of neem leaf. Feed composition at both growth phases (Starter and finisher) as recommended by NRC (1994) are presented in **Tables I** and **II**, respectively. The experiment lasted for eight weeks.

Table I. Composition (%) of starter diets (1-28 days) (Composición (%) de dietas iniciales (1-28 días)).

	Inclusion level of NLM (w/w)			
Ingredients	0	0.5	1.0	1.5
Maize	47.00	47.00	47.00	47.00
Soybean meal	18.50	18.50	18.50	18.50
Fish meal	2.00	2.00	2.00	2.00
Groundnut cake	17.50	17.50	17.50	17.50
Wheat offal	10.00	9.50	9.0	8.5
Azadirachta indica	0.00	0.5	1.0	1.5
Bone meal	3.00	3.00	3.00	3.00
Oyster shell	1.00	`1.00	1.00	1.00
Vitamin/min. Premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated analysis				
Crude protein (%)	23.02	23.03	23.03	23.04
Crude fibre (%)	4.40	4.42	4.44	4.46
Fat (%)	4.80	4.78	4.75	4.73
Ash (%)	9.22	8.96	8.70	8.44
Metabolizable energy (Kcal/Kg)	3046.13	3050.08	3054.03	3057.98

Table II. Composition (%) of finisher diets (29 – 56 days) (Composición (%) de dietas de acabado (29 – 56 días)).

	Inclusion level of NLM (w/w)			
Ingredients	0	0.5	1.0	1.5
Maize	53.50	53.50	53.50	53.50
Soya bean meal	16.50	16.50	16.50	16.50
Fish meal	0.40	0.40	0.40	0.40
Groundnut cake	13.80	13.80	13.80	13.80
Wheat offal	10.80	10.30	9.80	9.30
Neem leaf meal	0.00	0.50	1.00	1.50
Bone meal	3.00	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00	1.00
Vitamin/min. Premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated analysis				
Crude protein (%)	20.17	20.25	20.25	20.19
Crude fibre (%)	4.13	4.15	4.17	4.18
Fat (%)	6.96	6.94	6.92	6.90
Ash (%)	9.21	8.95	8.69	8.45
Metabolizable energy (Kcal/Kg)	3095.89	3099.98	3103.79	3107.77

Carcass characteristics

At the 56th day of experiment, one bird of average weight of each replicate was selected and fasted for 12 hours overnight to clear the gut. The live weight of the selected birds was determined before slaughtering. The birds were slaughtered via neck slit, bled properly and was dissected into cut up parts (head, neck, wings, chest, back, thigh, drumstick, shanks), organ (gizzard, liver, heart, kidney, lungs and spleen) and offals (intestine and fats) and weighed. All the values were expressed as the percentage of the live weight.

Meat pH

The pH of the meat of the broilers was tested using a handy digital pH meter. The meat was sprayed with distilled water because the operation requires some fluidity in the meat sample. The values obtain were recorded and compared.

Sensory Evaluation

The breast meat samples were cooked separately using 100ml water to a temperature of 65°C for 15 minutes in a water bath to produce cooked meat samples. The samples were sliced into 10 pieces and allowed to cool before serving 10 trained sensory panels. The chicken breast meats were coded according to the treatment. The trained sensory panelists evaluated the following: meat colour, juiciness, aroma, flavour, texture, saltiness and overall acceptability.

Table III. Proximate composition of neem leaf meal (*Azadirachta indica*) (Proximate composition of neem leaf meal (*Azadirachta indica*)).

Composition (%)	% Dry matter
Crude protein	16.59
Crude fibre	21.97
Ash	13.99
Nitrogen free extract	32.30
Moisture	12.80

Cooking Weight Loss

The breast meat samples were weighed before cooking in a water bath at a temperature of 65°C for 15 minutes. The cooking weight loss was determined by subtracting the cooked weight from the raw weight of the meat samples. The values were also expressed as the percentage of raw meat weight.

Refrigeration Loss

Samples of breast meat were weighed and placed in a refrigerator at temperature 10°C for 24hours. The breast meat samples were weighed after period of refrigeration to determine the weight loss due to refrigeration. The refrigeration weight loss was computed as weight before refrigeration minus weight after refrigeration

Statistical Analysis

Data collected were subjected to One-way analysis of Variance, in a complete randomized design. Significantly ($p<0.05$) different means were separated using Duncan's multiple Range Test (SAS, 2012).

Results and Discussion

The proximate analysis of the neem leaf meal is shown in **Table III**. The neem (*Azadirachta Indica*) leaf

Table IV. Carcass characteristics of broilers chickens fed diet contained neem leaf meal (Características de la canal de pollos de engorde alimentados con dieta con harina de hoja de neem).

	Inclusion level of neem leaf meal (%)				
Parameters	0	0.5	1.0	1.5	SEM
Live weight (g)	1616.67	1533.33	1433.33	1500.00	31.05
Eviscerated weight (g)	1152.20	1129.90	1066.20	719.10	87.80
Dressed weight (g)	943.93	921.00	864.80	866.53	26.34
Dressing percentage (%)	58.08	60.19	60.39	57.77	1.14
Cut-up parts (%)					
Head	2.75	2.82	2.63	2.57	0.05
Shank	5.29	5.58	4.94	5.05	0.19
Wings	9.19	9.44	9.19	8.56	0.22
Back	11.73[b]	12.59[ab]	14.31[a]	12.59[ab]	0.39
Neck	4.69	5.02	4.48	4.82	0.14
Thigh	10.40	10.81	10.76	10.87	0.27
Breast	15.50	15.79	16.32	17.51	0.37
Drumstick	10.54	10.34	10.50	10.19	0.31

[ab] Means in the same row, with different superscripts are significant (p<0.05)

meal contained 12.80% of moisture content, 21.97% of crude fibre, 16.59% of crude protein, 13.99% of ash and 32.30% of nitrogen free extract. Result obtained for the proximate composition of neem (*Azadiractha indica)* leaf meal was similar to the reported of Bonsu *et al.* (2012, p. 803). The crude protein value obtained in the present study was lower to the crude protein value of 18.90% reported by Sokunbi *et al.* (2003, p. 28). The crude fibre value was higher than 12.00% reported by Onyimonyi *et al.* (2009, p. 257). Differences observed in these values can be as a result of difference in plant age, soil type and other environmental factors.

The live weight and carcass weight of broilers chicken fed varying level of Neem leaf is presented in **Table IV**. The result did show any significant (P>0.05) differences in all the parameters measured. The result corroborates the finding of Kharde and Soujanya (2014, p. 800), who reported that garlic and neem leaf powder supplementation did not pose any influence on the visceral organs of broiler chicken. The result showed no significant (P>0.05) difference in all the cut-up parts except the back weight. The values of back ranged from 11.73% in birds fed with control diet to 14.31% in the birds fed with 1.0 % NLM inclusion level. Their counterparts fed with 0.5% and 1.5% recorded same value of 12.59%.

Table V shows different giblet and intestines of broiler chickens fed with neem leaf. The result showed no significant (P>0.05) differences on the all the measurements (Heart, kidney, lung, gizzard, spleen, liver, large intestine weight and length) across the treatment. The result agreed with result obtained by Hernández *et al*. (2004, p. 173) who reported no difference in the mean weight of gizzard, intestine, proventiculus and

Table V. Organs and offals weight of broiler chicken fed with Neem leaf meal (Peso de órganos y despojos de pollo de engorde alimentado con harina de hoja de neem).

	Inclusion level (%) of neem leaf meal				
Parameters	0	0.5	1.0	1.5	SEM
Organs (%)					
Heart	1.92	0.47	0.57	0.53	0.39
Kidney	0.21	0.37	0.46	0.43	0.04
Lung	0.63	0.61	0.80	0.58	0.04
Gizzard	1.69	2.54	2.56	2.34	0.20
Spleen	0.11	0.10	0.13	0.10	0.01
Liver	0.98	1.94	2.21	2.13	0.07
Large Intestine (%)	0.18	0.28	0.26	0.29	0.03
Small Intestine (%)	4.96	4.08	5.52	4.60	0.28
Caecum (%)	0.56	0.59	0.69	0.64	0.04
Large Intestine (cm)	10.50	10.83	7.97	10.73	0.59
Small Intestine (cm)	184.00	182.30	180.17	180.50	2.58
Length of caecum (cm)	38.30	39.00	36.00	36.30	1.26

Table VI. Effect of Neem Leaf Meal on the Refrigeration and Cooking Weight Losses of broiler chicken breast (Efecto de la harina de hoja de Neem en las pérdidas de peso de refrigeración y cocción de la pechuga de pollo de engorde).

	Inclusion level of Neem leaf meal (%)			
Parameters	0	0.5	1.0	1.5
Refrigeration				
Weight before refrigeration (g)	50.00±0.00	50.00±0.00	50.00±0.00	50.00±0.00
Weight after refrigeration (g)	48.3±0.28	48.73±0.66	49.33±0.04	48.97±0.38
Refrigeration weight loss (g)	1.70±0.92	1.27±0.66	0.67±0.04	1.03±0.38
Refrigeration weight loss (%)	3.40±1.85	2.54±1.32	1.33±0.08	2.07±0.76
Cooking				
Weight before cooking (g)	50.00±0.00	50.00±0.00	50.00±0.00	50.00±0.00
Weight after coking (g)	39.93±0.86	38.1±1.38	37.30±0.98	34.57±3.01
Cooking weight loss (g)	10.07±0.86	11.01±1.38	12.61±0.98	15.43±3.01
Cooking weight loss (%)	20.15±1.72	22.03±2.75	26.06±2.29	30.86±6.03

pancrease in broilers fed on two herbal plant extracts. It also corroborate the report of Durrani *et al*. (2008, p. 657) that neem extract did not have any significant effect on the visceral organs of broiler chicken. Ayoola *et al.* (2015, p. 146) also reported that, dietary neem leaf did not cause any significant change in liver, heart, lungs, gizzard, kidney and spleen.

The effect of different inclusion level of neem leaf meal in broiler chicken's diet on refrigeration and cooking weight losses of broiler chicken's meat is presented in **Table VI**. The result showed that there is no significant ($p>0.05$) difference in the refrigeration weight loss in gram and percentage, the values ranges from 0.67g (1.33%) in 1.0% NLM to 1.70g (3.40%) in control.

The effect of different inclusion levels of neem leaf meal in broiler chicken on the pH and sensory evaluation is presented in **Table VII**. The pH was not significantly ($p > 0.05$) affected. The pH value ranged from 5.10 to 5.63. The results on sensory evaluation showed that all the parameters were not influenced ($p>0.05$) by the levels of neem leaf meal.

The pH values of breast meat samples are in agreement with the report of Qwele *et al.* (2013, p. 296) that dietary supplementation of dietary mixtures of Moringa (*Moringa oleifera*) leaves, broiler finisher and crushed maize had no effect on pH. When animals are slaughtered, glycogen is broken down to glucose and glucose undergoes glycolysis. In the absence of oxygen, lactic acid is produced which is responsible for the drop of muscle pH such as drop aid in the conversion of muscle to meat (Muchenje *et al.* 2008a, p. 1700). Meat pH is a vital characteristic that influences the acceptability of meat. Higher meat pH results in lower lightness, implying that high meat pH is darker than normal meat pH (Muchenje *et al.* 2008b, p. 20). Non-significance in all other parameters been observed for the sensory evaluation; colour, juiciness, meaty flavour, saltiness, overall acceptability and overall flavour and tenderness for all the treatments were in accordance with Bonsu *et al.* (2012, p. 804) who studied the medicinal response of broiler chickens to diets containing neem (*Azadirachta indica*) leaf meal, haematology and meat sensory analysis and did not find significant difference in the tenderness of Cooked chicken breast meat, that there were no significant differences in the aroma and juiciness of cooked meat samples. Thus, acceptability is a function of the rating in palatability and the level of a product to a consumer (Joseph *et al.* 1995, p. 66).

Table VII. Effect of Neem Leaf on the Sensory Qualities of Broiler Breast Meat (Efecto de la hoja de Neem en las cualidades sensoriales de la carne de pollos de engorde).

	Inclusion level of Neem leaf meal (%)			
Parameters	0	0.5	1.0	1.5
Meat pH	5.63±0.27	5.10±0.10	5.3±0.15	5.13±0.03
Colour	6.63±0.07	6.73±0.23	6.53±0.18	6.4±0.45
Juiciness	6.47±0.15	6.87±0.62	6.07±0.26	6.53±0.52
Meat flavour	7.17±0.23	6.20±0.06	6.07±0.26	6.53±0.52
Tenderness	6.43±0.55	6.37±0.19	6.45±0.62	6.27±0.24
Saltiness	5.10±0.12	5.20±0.26	4.87±0.12	4.63±0.26
Overall flavour	6.77±0.09	6.70±0.36	6.13±0.33	6.37±0.12
Overall acceptability	6.83±0.32	6.70±0.15	6.57±0.27	7.27±0.59

Meat tenderness has been described to be the most determining factor to meat acceptability (Strydom *et al*. 2000, p. 79). This is due to the amount of connective tissue present as the amount of connective tissue is the contributing factor on sensory characteristics (Muchenje *et al*. 2008a, p. 1700). Waskar *et al*. (2009, p. 275) reported that the quality of meat was not affected by the medicinal plants used in terms of aroma, initial impression of juiciness and connective tissue. Tenderness of meat also depends on the type of muscle (Muchenje *et al*. 2010, p. 424) and the tender the meat the higher it is acceptable to consumers (Waskar *et al*. 2009, p. 276).

The effect of different inclusion of neem (*Azadirachta indica)* leaf meal on the proximate composition of broiler chicken breast meat samples is presented in **Table VIII**. The result showed that only ash content was significantly ($p<0.05$) influenced among the measured indices. The total ash content of the breast meat samples increased with the increased levels of neem

Table VIII. Proximate composition of breast meat samples of broiler fed varying levels of neem (*Azadirachta indica*) (Composición aproximada de muestras de carne de mama de pollo de engorde alimentado según diferentes niveles de neem (Azadirachta indica)).

	Inclusion level of NLM (%)			
Parameters	0	1.5	0.5	1.0
Moisture	71.27±0.72[ab]	72.60±0.71[ab]	70.9±0.58[b]	73.27±0.47[a]
Crude protein	23.60±0.43	23.37±0.69	23.54±0.41	23.61±0.40
Crude fat	0.36±0.14	0.76±0.25	0.54±0.01	0.45±0.18
Total ash	0.91±0.01[b]	0.97±0.04[ab]	0.98±0.05[ab]	1.04±0.03[a]
NFE	3.85±0.64	3.30±1.20	3.91±0.74	1.69±0.76

[ab] Means in the same row, with different superscripts are significant (p<0.05)

leaf meal. This could be attributed to the higher ash content in neem leaf meal than wheat offal. Aduku (1993, p. 2) reported that wheat offal consists 6.4% ash.

CONCLUSION

The study concluded that inclusion of neem leaf meal up to 1.5% w/w as a replacement to wheat offal in the diet of broiler without antibiotics competed favourably with antibiotics on carcass and meat quality of broiler chicken.

ACKNOWLEDGMENT

The authors acknowledged the effort of Miss Adegbite, the Technologist in the Department of Animal Production and Health who rendered assistance during the meat quality study.

COMPLIANCE WITH ANIMAL WELFARE

The study complies with the standards established by ethics and animal welfare committees of the University.

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