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Evaluation of Processing Methods on the Feeding Value of Grass Pea to Broilers

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Abstract: Grass pea is a widely available grain legume that contains a neurotoxin ODAP that has negative effects in humans and animals. Various treatment methods were tested to select methods that are more effective. Socking and cooking at 60, 75, 90 °C and boiling temperatures were found to be relatively effective. Diets containing grass pea prepared using these methods along with diets that contained untreated grass pea and a control that did not contain any grass pea were tested in a broiler trial. Grass pea was included by replacing Noug *(Guizotia abyssinica)* cake. Four hundred twenty unsexed one day old Cobb broiler chicks of similar body weight were divided into seven groups of 60 and further randomly sub-divided into three replicates of 20 chicks and placed in the experimental pens were used. The study showed that total replacement of Noug cake by boiled grass pea is possible without significantly reducing performance (gain and feed efficiency). Cooking at 90 °C can also be considered pending economic evaluation since it was also similar results to the control diet ($p>0.05$) in terms of feed efficiency. Performance of broilers on the rations containing grass pea treated using the other methods seem to have depressed performance too much. Comparison of performance during the starter and finisher phases indicates that most of the depressing effects seem to have occurred during the starter phase. There was no visible sign of lathyrism in any of the treatment groups in this study. It is suggested that further economic analysis of using the methods be conducted. Further work on the possibility of using grass pea only during the finisher phase following the apparent reduction of the negative impacts of feeding grass pea at this stage observed in this study is also proposed.

Key words: Broiler, grass pea, lathyrus, ODAP, protein source

Introduction

The use of Grass pea (*Lathyrus sativus* L) as grain legumes for human and animal consumption dates to the Neolithic period (Hanbury *et al*., 2000). Grass pea is used widely for human food in Ethiopia and the Indian sub-continent. It is a low production cost legume adapted to harsh and low rainfall environments having considerable potential as a good quality, cheap protein source. Currently, Grass pea occupies some 9% of the cultivated area and represents almost 8% of the total production of food legumes in Ethiopia (EARO, 2000) and is the cheapest available pulse crop in the market. Production is increasing from time to time. It is also expected to expand further due to more and more land becoming moisture deficient and recurrence of drought conditions.

The grain of *L. sativus* contains a neurotoxin, 3-(-N-oxalyl)-L-2, 3-diamino propionic acid (ODAP), which can cause paralysis of the lower limbs (lathyrism). The presence and role of ODAP was unknown until the 1960s. Due to the occurrence of lathyrism in humans, recent efforts of plant breeding have focused on development of cultivars with low ODAP concentrations EARO (2000). Breeding work requires time to come up with appropriate cultivars for the different environments. There is, therefore, need for developing methods of reducing the negative effects of ODAP and use grass pea as feed. Many workers have presented mixed reports of methods to reduce ODAP content of grass pea (Tekle Haimanot *et al*., 1993; Padmajaprasad *et al*., 1997)

Feed accounts for 70-85% of the production cost of poultry (Opara, 1996). The bulk of the feed cost arises from protein concentrates. The prices of conventional protein sources have soared so high in recent times that it is becoming uneconomical to use them in poultry feeds. There is need, therefore, to look for locally available and cheap sources of feed ingredients. One possible source of cheap protein is Grass pea. Considering the constant increase of Grass pea production in the low rainfall/drought prone areas and its low cost coupled with the shortage and high cost of protein sources in chicken rations, justifies investigation into possible use of Grass pea as an alternative plant protein source for poultry in Ethiopia.

This trial was, therefore, designed to examine the nutritional value of Grass pea subjected to different methods of treatment as a substitute for Noug (*Guizotia Abyssinia*) cake in broiler diets.

Table 1: Ingredient and nutrient composition of starter diets

Ingredients (kg/100 kg)	Control (0 GP)	Untreated	Socked	Cooked at 60 °C	Cooked at 75 °C	Cooked at 90 °C	Boiling temperature
Maize	42	48	48	48	48	48	48
Wheat shorts	8	--	--	--	--	--	--
Noug seed cake[1]	35	--	--	--	--	--	--
Meat and bone meal	13.5	15.5	15.5	15.5	15.5	15.5	15.5
Vitamin-mineral premix[2]	1	1	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Grasspea	--	35	35	35	35	35	35
Nutrient composition (% DM)							
Dry matter	90.1	88.94	88.30	88.34	88.32	88.65	88.48
Crude protein	23.2	21.12	21.94	21.78	21.82	21.14	21.04
Crude Fibber	9.3	3.5	3.5	3.5	3.5	3.5	3.5
Metabolisable Energy (Kcal/kg)	2845	2831	2831	2831	2831	2831	2831
Calcium	1.64	1.65	1.65	1.65	1.65	1.65	1.65
Total phosphorus	0.92	1.06	1.06	1.06	1.06	1.06	1.06

[1]Guizotia abyssinica; [2]Commercial premix containing per kg: 625000 IU Vitamin A; 125000 IU Vitamin D3; 1250 IU Vitamin E; 1500 mg Fe; 1250 mg Cu; 3000 mg Zn; 3750 mg Mn; 15 mg Co; 50 mg I; 10mg Se

Table 2: Ingredient and nutrient composition of finisher diets

Ingredients (kg/100 kg)	Control (0 GP)	Untreated	Socked	Cooked at 60 °C	Cooked at 75 °C	Cooked at 90 °C	Boiling temperature
Maize	56	56	56	56	56	56	56
Noug seed cake[1]	33	--	--	--	--	--	--
Meat and bone meal	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Vitamin-mineral premix[2]	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Grasspea	--	33	33	33	33	33	33
Nutrient composition (% DM)							
Dry matter	89.88	89.75	89.61	89.64	89.63	91.36	89.78
Crude protein	20.8	19.0	19.66	19.62	19.64	19.28	18.76
Crude Fibber	8.4	3.5	3.5	3.5	3.5	3.5	3.5
Metabolisable Energy (Kcal/kg)	2971	2905	2905	2905	2905	2905	2905
Calcium	1.21	1.04	1.04	1.04	1.04	1.04	1.04
Total phosphorus	1.02	0.74	0.74	0.74	0.74	0.74	0.74

[1]Guizotia abyssinica; [2]Commercial premix containing per kg: 625000 IU Vitamin A; 125000 IU Vitamin D3; 1250 IU Vitamin E; 1500 mg Fe; 1250 mg Cu; 3000 mg Zn; 3750 mg Mn; 15 mg Co; 50 mg I; 10mg Se

Materials and Methods

The study area: The study was conducted at the Debre Zeit Agricultural Research Centre (DZARC), Ethiopia located at an altitude of 1900 m.a.s.l. The average annual rainfall is 851 mm and the average minimum and maximum temperatures range from 8.9 to 24.3 °C with a mean of 16.6 °C (DZARC, 1992)

Grass pea processing: The grass pea grain required for the trial was obtained from the local market. The material was subdivided into lots that were processed as follows:

Socking: The socked Grass pea was prepared by socking The Grass pea at the ratio of 50 Kg of the grain in 70 liters of water for 24 hours. The material was then sun-dried on polyethylene sheets.

Cooking treatments: The Grass pea was cooked using cookers whose temperatures were thermostatically controlled to produce the desired temperatures of 60, 75, 90 °C and boiling temperature. The Grass pea was cooked for 20 minutes, found to result in the optimum reduction the ODAP content of grass pea based on earlier tests (unpublished data). It was then spread on polyethylene sheets and sun-dried.

The drying in all cases continued until the moisture content was reduced to 10-12%. The dried grass pea was then ground and saved for the trial.

Chemical analyses: Representative samples of the untreated, water socked and cooked Grass pea as well as other experimental feed ingredients were analyzed for proximate principles based on the standard procedures of the Association of Official analytical Chemists (AOAC, 1980). Contents of ODAP in the Grass pea samples were determined at the ICARDA laboratory using standard procedures. ME was estimated by employing the formula proposed by King and Travener (1975).

Treatment rations: Isoenergetic and isonitrogenous broiler starter and finisher rations with the untreated

Table 3: Chemical composition of the Grass pea treated using different methods and Noug cake used in the trials

GRASSPEA	DM%	% Of dry matter					
		CP	NDF	ADF	ASH	ORGANIC MATTER	β-ODAP
Untreated	89.91	26.64	12.82	9.68	2.22	97.78	0.495
Socked in water (24 hours)	89.48	29.59	23.55	10.26	2.35	97.65	0.352
Cooked at 60 °C	89.59	28.54	15.65	8.96	2.28	97.72	0.243
Cooked at 75 °C	89.55	28.60	19.98	10.47	2.19	97.81	0.180
Cooked at 90 °C	90.48	27.54	18.39	10.01	2.21	97.72	0.180
Cooked at boiling temperature	90.01	25.93	18.37	11.18	2.20	97.80	0.168
NOUG CAKE	89.80	33.00	43.70	30.70	3.40	96.60	--

Table 4: β-ODAP composition of Grass pea treated using different Methods and time periods (% of DM)

Treatment Methods	ODAP	% Reduction*	Cooking period (Minutes)					
			10		20		30	
			ODAP	% Reduction	ODAP	% Reduction	ODAP	%Reduction
Untreated	0.495	-	-	-	-	-	-	-
Roasted	0.393	20.61	-	-	-	-	-	-
Socked in water (24 hours)	0.352	28.89	-	-	-	-	-	-
Cooked at 60 °C	-	-	0.359	27.47	0.243	50.91	0.431	12.93
Cooked at 75 °C	-	-	0.358	27.68	0.180	63.64	0.214	56.77
Cooked at 90 °C	-	-	0.187	62.22	0.180	63.64	0.278	43.84
Cooked at boiling temperature	-	-	0.265	46.46	0.168	66.67	0.219	55.76

* = Reduction in ODAP content as a result of treatment (percent of content of untreated grass pea)

Table 5: Effect of total replacement of Noug seed cake in broiler starter diets (0-29 days) by Grass pea treated using different methods

Parameters	Methods of Grass pea treatment							SE
	Control (0 GP)	Untreated	socked	cooked at 60 °C	cooked at 75 °C	cooked at 90 °C	Boiling temperature	
Total feed intake (g/bird)	1261.66^{a}	849.43^{c}	848.73^{c}	810.93^{c}	869.03^{c}	1011.56^{b}	1110.84^{b}	37.01
Mean feed intake (g/bird/day)	43.51^{a}	29.29^{c}	29.27^{c}	27.96^{c}	29.97^{c}	34.88^{b}	38.30^{b}	1.28
Initial body weight (g/bird)	38.58^{NS}	38.26^{NS}	38.19	38.36^{NS}	38.28^{NS}	38.66^{NS}	38.49^{NS}	0.23
Final body weight (g/bird)	544.15^{a}	354.30^{c}	362.80^{c}	360.60^{c}	376.81^{c}	473.44^{b}	528.47^{a}	15.34
Daily gain (g/bird/day)	17.44^{a}	10.90^{c}	11.19^{c}	11.11^{c}	11.67^{c}	14.99^{b}	16.89^{a}	0.53
Gain/bird(g)	505.58^{a}	316.05^{c}	324.61^{c}	322.25^{c}	338.53^{c}	434.78^{b}	489.98^{a}	15.47
Feed conversion ratio (feed: gain)	2.50^{b}	2.69^{a}	2.62^{ab}	2.52^{b}	2.57^{ab}	2.33^{c}	2.27^{c}	0.04
Mortality	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0

^{abcd}Means within a row followed by different superscripts are significantly different ($p<0.05$); NS = Non-significant

Grass pea, socked Grass pea and Grass pea cooked at varying temperatures replacing Noug cake (most commonly used plant protein supplement in Ethiopia) in the following order was formulated: 0-conventional broiler ration that did not contain Grass pea served as a control, and 100% of Noug cake was replaced by Grass pea treated using methods indicated in Table 1 and 2. The treatment rations were formulated to contain 2800 kcal ME/kg DM and 22% CP for the starter rations (day old to 29 days of age) and 2900 kcal ME/kg DM and 20% CP during the finisher phase (30 to 56 days of age).

Experimental Animals and their Management: Four hundred twenty mixed sex day-old Cobb broiler chicks of similar body weight were divided into seven groups of 60 chicks. Each of the seven groups of chicks were further randomly sub-divided into three replicates of 20 chicks and placed in the experimental pens at a density of 10 chicks/m^2. The treatment rations were randomly assigned to the pens. Birds were provided daily with a known amount of feed *ad libitum*. Refusals were measured and recorded daily. Water was also offered *ad libtum*. Routine vaccination and health care was given as necessary. Group body weight measurements were taken for each replicate at the beginning of the experiment and every week then after. Mortality was measured as it occurred.

Carcass measurements: At the end of the experiment, two birds (one male and one female) from each

replication were randomly selected and slaughtered for carcass measurements. Slaughter of the birds was done as recommended by Kubena *et al.* (1974). Dressing percentage was calculated as percent of carcass weight to slaughter body weight. Weight of abdominal fat was measured and expressed as percentage of slaughter weight and also as percentage of the carcass weight to get an idea of the proportion of the fat in the carcass. Abdominal fat is well correlated with body fatness in broilers (Hood, 1984) Thigh circumference was measured in centimeters using a measuring tape.

Experimental Design and Statistical analyses: The experimental design employed in this study was the Completely Randomized Design (CRD). Variance between treatments was analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis Systems (SAS, 1987). When the analysis of variance revealed the existence of significant differences among the treatment means, the Duncan Multiple Range Test (Duncan, 1955) was used to locate treatment means that were significantly different from one another. Data for the finisher phase were also analyzed by taking the starting weight of the animals as a covariate to account for the effect of the weight difference between the groups at the beginning of the finisher phase as a result of the effects during the starter phase.

Results

Chemical compositions of Grass pea and Noug cake: The chemical compositions of the Grass pea grain and the Noug cake used in the study are presented in Table 3. Compared to the Noug cake it replaced, Grass pea used in this study contained crude protein levels ranging from 25.93 to 29.59% relative to 33% for Noug cake, but it has less fibre which would have made it a better feed source for broilers compared to Noug cake, had it not been for the anti nutritional factors it contains.

Effect of treatment on ODAP content of Grass pea: The effects of different treatment methods on the composition of ODAP are given in Table 4. The effects of roasting, socking and cooking at different temperatures on ODAP content were studied and the results are presented in Table 4. Roasting resulted in only marginal reduction of ODAP content (20.61%). Socking for 24 hours was slightly better (28.89% reduction). Cooking for 10, 20 and 30 minutes had variable effects. Cooking for 20 minutes resulted in clearly better reduction in ODAP content compared to the shorter duration of 10 minutes or the longer period of 30 minutes for all temperature intensities. There was also a trend of increasing reduction in ODAP content with increasing temperature for the 20-minute cooking procedure.

Performance of broilers during the starter phase (0-29 days of age): Performance of broilers fed treatment rations during the starter phase is presented in Table 5. Feed intake was highest ($p<0.05$) for the control (no grass pea) diet. It was followed by rations containing cooked at 90 ^{o}C and boiling temperatures which resulted in significantly higher ($p<0.05$) intakes compared to diets based on grass pea cooked at lower temperatures of less than 75 ^{o}C, socked and untreated. These were similar to one another ($p>0.05$).

Body weight gain of broilers on the boiled grass pea based diet and the control was similar ($p>0.05$). Those on the 90 ^{o}C cooked grass pea containing diet were intermediate. Performance of the rest was lower ($p<0.05$). Performance of the treatments on the lower side was similar ($p>0.05$).

Broilers on the boiled and 90 ^{o}C cooked grass pea based diets had the least ($p<0.05$) feed requirement per unit of gain. Highest feed requirement per unit gain was for birds on the ration containing untreated grass pea followed by birds on the ration containing socked grass pea and cooked at 60 and 75 ^{o}C.

There was no mortality of birds from any of the treatment groups during the starter phase.

Performance of broilers during the finisher phase (30-56 days of age): Table 6 shows the performance of broilers on diets containing different levels of Grass pea. All grass pea-containing treatments were inferior ($p<0.05$) in terms of feed intake compared to the control. Cooking at boiling temperature and 90 ^{o}C were the next highest. The low temperature (60 and 75 ^{o}C) cooking, socking and untreated grass pea were similar and occupied the third and lowest category.

Gain was highest ($p<0.05$) for the control group followed by the ration containing boiled grass pea. Next was the 90 ^{o}C cooked grass pea that was better ($p<0.05$) than the low temperature cooked, socked and untreated grass pea treatments. There was no significant difference ($p>0.05$) among the low performing group. Highest ($p<0.05$) feed requirement per unit gain was for broilers on the ration based on the untreated grass pea while the group on the boiled grass pea based diet required the least amount of feed per unit gain. There was no mortality among broilers in all the treatments.

There was already a difference in the starting weight of the birds in the different treatments due to the effect of the starter phase because the starter and finisher phases were conducted in a continuous trial. Analysis of the data was conducted by taking the starting weight of the animals as a covariate to remove the effects of the weight difference at the start of the finisher phase between the groups. The result of the covariance

Table 6: Effect of total replacement of Noug seed cake in broiler finisher diets (30-56 days) by Grass pea treated using different methods

Parameters	Methods of Grass pea treatment							SE
	Control (0 GP)	Untreated	Socked	Cooked at 60°C	Cooked at 75°C	Cooked at 90°C	Boiling temperature	
Total feed intake (g/bird)	3425.10^{a}	2586.92^{c}	2574.58^{c}	2394.24^{c}	2570.45^{c}	2939.24^{b}	3077.95^{b}	91.70
Mean feed intake (g/bird/day)	126.85^{a}	95.81^{c}	95.35^{c}	88.67^{c}	95.20^{c}	108.86^{b}	114.00^{b}	3.40
Initial body weight (g/bird)	544.15^{a}	354.30^{c}	362.80^{c}	360.60^{c}	376.81^{c}	473.44^{b}	528.47^{a}	15.54
Final body weight (g/bird)	1921.84^{a}	1257.16^{c}	1392.54^{c}	1250.53^{c}	1382.12^{c}	1645.37^{b}	1776.68^{ab}	58.25
Daily gain (g/bird/day)	51.03^{a}	33.44^{c}	38.14^{c}	32.96^{c}	37.23^{c}	43.40^{b}	46.23^{ab}	1.69
Gain/bird(g)	1377.69^{a}	902.86^{c}	1029.74^{c}	889.93^{c}	1005.31^{c}	1171.94^{b}	1248.21^{ab}	45.63
Feed conversion ratio (feed: gain)	2.49^{c}	2.89^{a}	2.50^{bc}	2.69^{b}	2.56^{bc}	2.51^{bc}	2.47^{c}	0.06
Mortality	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0

^{abcd}Means within a row followed by different superscripts are significantly different ($p<0.05$); NS = Non-significant

Table 7: Effect of total replacement of Noug seed cake in broiler finisher diets (30-56 days) by grass pea treated using different methods (Initial body weight taken as a covariate)

Parameters	Methods of Grass pea treatment						
	Control (0 GP)	Untreated	Socked	Cooked at 60°C	Cooked at 75°C	Cooked at 90°C	Boiling temperature
Total feed intake (g/bird)	2942.03±149.38^{a}	2897.89±109.03^{a}	2850.02±101.48^{ab}	2678.87±103.40^{b}	2787.28±89.98^{ab}	2751.93±84.77^{ab}	2660.47±133.45^{b}
Mean feed intake (g/bird/day)	108.86±5.53^{a}	107.33±4.04	105.56±3.76^{ab}	99.22±3.83^{b}	103.23±3.33^{ab}	101.93±3.14^{ab}	98.53±4.94^{b}
Final body weight (g/bird)	1550.46±69.16^{ab}	1496.23±50.48^{a}	1604.30±46.98^{a}	1469.35±47.87^{b}	1548.82±41.66^{ab}	1501.37±39.25^{ab}	1455.72±61.78^{b}
Daily gain (g/bird/day)	41.55±2.56^{ab}	39.54±1.87^{b}	43.54±1.74^{a}	38.54±1.77^{b}	41.49±1.54^{ab}	39.73±1.45^{ab}	38.05±2.29^{b}
Gain/bird(g)	1121.81±69.16^{ab}	1067.57±50.48^{b}	1175.64±46.98^{a}	1040.69±47.87^{b}	1120.16±41.66	1072.72±39.25^{ab}	1027.07±61.78^{b}
Feed conversion ratio (feed: gain)	2.72±0.12^{ab}	2.74±0.09^{a}	2.37±0.08^{b}	2.55±0.09^{b}	2.46±0.08^{b}	2.60±0.07^{ab}	2.67±0.11a^{b}
Mortality	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}

^{abcd}Means within a row followed by different superscripts are significantly different ($p<0.05$); NS = Non-significant

Table 8: Effect of total replacement of Noug seed cake in broiler diets (0-56 days) by grass pea treated using different methods

Parameters	Methods of Grass pea treatment							SE
	Control (0 GP)	Untreated	Socked	Cooked at 60°C	Cooked at 75°C	Cooked at 90°C	Boiling temperature	
Total feed intake (g/bird)	4686.75^{a}	3436.36^{c}	3423.31^{c}	3205.16^{c}	3439.47^{c}	3950.80^{b}	4188.79^{b}	120.16
Mean feed intake (g/bird/day)	83.69^{a}	61.36^{c}	61.13^{c}	57.24^{c}	61.42^{c}	70.55^{b}	74.80^{b}	2.15
Initial body weight (g/bird)	38.58^{NS}	38.26^{NS}	38.19^{NS}	38.36^{NS}	38.28^{NS}	38.66^{NS}	38.49^{NS}	0.23
Final body weight (g/bird)	1921.84^{a}	1257.16	1392.54^{c}	1250.53^{c}	1382.12^{c}	1645.37^{b}	1776.68^{ab}	58.25
Daily gain (g/bird/day)	33.63^{a}	21.77^{c}	24.18^{c}	21.65^{c}	24.00^{c}	28.69^{b}	31.04^{ab}	1.04
Gain/bird(g)	1883.27^{a}	1218.90^{c}	1354.35^{c}	1212.17^{c}	1343.84^{c}	1606.72^{b}	1738.19^{ab}	58.24
Feed conversion ratio (feed: gain)	2.49^{c}	2.84^{a}	2.53^{bc}	2.65^{b}	2.56^{bc}	2.46^{c}	2.41^{c}	0.05
Mortality	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0^{NS}	0

^{abcd}Means within a row followed by different superscripts are significantly different ($p<0.05$); NS = Non-significant

Table 9: Effect of partial replacement of Noug seed cake in broiler diets (0-56 days) by Grass pea treated using different methods on slaughter performance

Parameters	Treatment Method							SE	Sex		SE
	Control (0 GP)	untreated	socked	cooked at 60°C	cooked at 75°C	cooked at 90°C	Boiling temp.		Male	Female	
Slaughter weight (g)	1928.67^{a}	1377.50^{bc}	1628.67^{b}	1525.00^{bc}	1545.00^{bc}	1783.00^{ab}	1875.00^{ab}	93.72	1650.76^{NS}	1681.76^{NS}	50.10
Dressing percentage (%)	67.32^{NS}	65.31^{NS}	66.79^{NS}	64.94^{NS}	66.95^{NS}	69.06^{NS}	67.98^{NS}	1.43	66.90^{NS}	66.92^{NS}	0.76
Abdominal fat weight (g)	44.13^{a}	25.57^{b}	36.85^{ab}	29.55^{b}	33.72^{ab}	37.92^{ab}	47.63^{a}	4.99	28.42^{b}	44.54^{a}	2.67
Abdominal fat (%carcass weight)	3.40^{NS}	2.78^{NS}	3.33^{NS}	2.98^{NS}	3.24^{NS}	3.04^{NS}	3.72^{NS}	0.35	2.54^{b}	3.89^{a}	0.19
Abdominal fat (% body weight)	2.29^{NS}	1.84^{NS}	2.22^{NS}	1.92^{NS}	2.17^{NS}	2.11^{NS}	2.51^{NS}	0.23	1.69^{b}	2.61^{a}	0.13
Thigh Circumference (cm)	13.03^{ab}	11.97^{b}	12.40^{b}	12.03^{b}	12.33^{b}	12.97^{ab}	13.63^{a}	0.38	12.70^{NS}	12.55^{NS}	0.21

^{abcd}Means within a row followed by different superscripts are significantly different ($p<0.05$); NS = Non-significant

analysis is presented in Table 7. The differences in the performance seem to narrow down. Groups that were performing poorly during the starter phase seem to have compensated during the finisher phase. The broilers on the untreated and socked grass pea based diets drastically improved their intake and other performance relative to the other treatment groups. Broilers on the socked grass pea based diets had the most efficient feed utilization while those on the untreated grass pea were the least efficient feed utilizers.

Performance of broilers for the whole period (0-56 days of age): Overall performance of broilers on the experimental diets for the whole period is presented in Table 8. Feed intake was significantly affected by treatment of grass pea. Broilers on the control group consumed the largest ($p<0.05$) quantity of feed followed by the boiled and 90 ^{o}C cooked grass pea. Intakes were least ($p<0.05$) for the low temperature cooked, socked and untreated grass pea diets.

Gain was highest ($p<0.05$) for the control followed by the boiled grass pea group. The effect of cooking at 90 ^{o}C was similar ($p>0.05$) to boiling. Low temperature cooked (60 and 75 ^{o}C), socked and untreated grass pea resulted in similarly ($p>0.05$) low gains. Birds on the untreated grass pea containing diet required the largest ($p<0.05$) quantity of feed per unit gain of 2.84 kg. Requirements were least for the boiled grass pea, 90 ^{o}C cooking and control group. No mortality was recorded for any of the groups.

Carcass Measurements: Results of carcass measurement are presented in Table 9. There was no significant ($p>0.05$) interaction between type of diet and sex. Only diet and sex were important in affecting carcass performance. There was no difference among the groups dressing and abdominal fat percentages ($p>0.05$). Abdominal fat weight was, however different ($p<0.05$) where birds on the boiled grass pea containing diet and the control had more abdominal fat. Birds on the untreated grass pea containing diet had the least abdominal fat. The situation was similar for thigh circumference.

There was no significant difference between male and female birds in dressing percentage and thigh circumference. Females had significantly more ($p<0.05$) abdominal fat weight and abdominal fat percent.

Discussion

The results of this study showed that total replacement of Noug cake by boiled grass pea is possible without significantly reducing performance (gain and feed efficiency). Cooking at 90 ^{o}C can also be considered pending economic evaluation since it was also similar to the control diet ($p>0.05$) in terms of feed efficiency. Performance of broilers on the rations containing grass pea treated using the other methods seem to have depressed performance too much. Comparison of performance during the starter and finisher phases indicates that most of the depressing effects seem to have occurred during the starter phase. Groups that performed poorly during the starter phase seem to have improved later on. The improvement, however, was not high enough to reverse the performance over the whole period. This implies that the effect of ODAP was more during the starter phase or the birds may have adapted to the effect. One would expect the effects of ODAP to be more during the finisher phase when total intake of ODAP is greater as a result of the higher feed intake. Olney *et al.* (1976) found that young mice showed symptoms of lathyrism and had 0.11µ mol g-1 ODAP while adult mice exposed to similar grass pea showing trace or no ODAP and no symptoms of lathyrism. They suggest exclusion of ODAP by the blood-brain barrier. Padmanaban (1980) suggested greater excretion of ODAP by older animals to be a more important cause for the difference.

There was no visible sign of lathyrism in any of the treatment groups in this study. This could be because the feeding period may not have been long enough for these effects to appear. Tekle Haimanot *et al.* (1993) indicate that lathyrism appears after a long period of feeding on grass pea.

Reduction in feed cost is basic for profitability of broiler operations. The tested methods of grass pea treatment involve varying processing cost. It is, thus, suggested that further economic analysis of using the methods is warranted. Further work on the possibility of using grass pea only during the finisher phase following the apparent reduction of the negative impacts of feeding grass pea at this stage observed in this study is also worthwhile.

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