Original Research Article

EFFECTS OF DIFFERENT PROCESSING METHODS OF *D.regia* SEEDS ON AMINO ACID COMPOSITION OF EXPERIMENTAL DIETS FED *Heterobranchus bidorsalis* FISH

Abstract

This study investigated the effects of different processing methods of *Delonix regia* seeds on amino acids composition of experimental diets fed *H.bidorsalis* . Ten isonitrogenous diets (40% crude protein) were formulated with cooked, raw, and fermented *Delonix regia* seeds at 0% (Control), 10%, 20% and 30% inclusion levels respectively. Data was analysed using Analysis of Variance, significant differences in means were separated using Duncan Multiple Range Test. All the essential amino acids (lysine, arginine, threonine, valine, methionine, isoleucine, leucine and phenylalanine) differs significantly at different inclusion levels among the treatments with the exception of histidine which was statistically similar ($P > 0.05$) across the dietary treatments. The activity of essential and non- essential amino acid concentration was higher in cooked than the fermented and raw *Delonix regia* seeds. It was concluded that cooked *Delonix regia* seeds at 10% inclusion levels had the highest activities of essential and non-essential amino acids.

Key words: Amino acids, *Delonix regia,* fermentation, cooking

INTRODUCTION

Fish feeds constitutes 60-75% of total cost of aquaculture production (Oyegbile, 2018; Yola and Onuora, 2012) which is expensive and has led to studies on how to reduce the high cost of fish feed manufacturing using alternative feed ingredients (Benitez, 1989). Generally, the ingredients that are essential for fish feed formulation are proteins and amino acids, lipids, carbohydrates, vitamins and minerals. In addition, preservatives and attractants are also incorporated into fish feeds to extend shelf life and enhance feed palatability respectively (Robinson et al., 2006). Protein is the major concern during formulation of fish feed. It is the most expensive components in fish feed and the important factors contributing to the growth performance of cultured species (Deng et al., 2011). It is the basic nutrient needed in fish feed ingredients (Ayinla, 1991). Protein requirement in fish diet can be related with the general energy requirement of the fish at certain water temperature and the ability to gain weight at present capacity (Findley and Ludin, 1980). The quality of a feed protein depends not only on nitrogen content, but also on constituent amino acids and their digestibility (Benitez, 1989). Diet formulation based on digestible amino acids will allow the use of alternative protein sources with low digestibility coefficients, because such formulation will improve the precision of least-cost diets and reduce nitrogen excretion from livestock operations (Fagbenro, 1998). Although the advantages of the digestible amino acid are recognized, diet formulation based on the total amino acid content is still widely used in many parts of the world. In the future, however, economic reasons will compel the fish industry to increase the use of an array of cheaper, alternative protein supplements with low digestibility coefficients in feed formulation. Amino acids are the substance derived from the ultimate product of digestion. There are about twenty naturally available amino acids which includes arginine, histidine, isoleucine, leucine, lysine, methionine, phenyalanine, protein, threonine,

alanine, aspartic acid, asparagine, cystine, glutamic acids, glutamine, proline, tryptophan, valine, serine, tyrosine (Hardy, 1990) but only the first ten are essential for fish growth because they are not synthesized in fish and must be provided in the feed, because of this they are called "essential or indispensible" amino acids (Hardy, 1990). A particularly important amino acid for growth is lysine. Protein rich in lysine can be obtained from legume, fish meal, blood meal, or meat and bone meal. Tryptophan is very important for growth of all cells and normal development, it is used in cell profile ration. Arginine and histidine play an important role in maintaining a normal and healthy bloodstream and has other complex functions (NRC, 1993). Fish and other animals are able to synthesize their non-essential amino acids from carbohydrates and lipids and other nitrogen compounds but mainly from other non-essential amino acids. Any diet deficient in any of the essential amino acid will cause depressed appetite and growth rate of fish (Hardy, 1990). Therefore, this study is designed to evaluate the effect of different processing methods of *Delonix regia* seeds on the amino acid composition of diets fed *H.bidorsalis* fish.

MATERIALS AND METHODS

The experiment was conducted at the aquaculture production technology unit of the Skill Acquisition and Development Centre, NAERLS, Ahmadu Bello University, Zaria, located at latitude 11^{o} 09^{1} 45.2^{1} N and longitude 7^{o} 38^{1} 17.9^{1} E. The experiment was conducted from September 2015 to March 2016.

Collection of *Delonix regia* (Flamboyant) Seeds

Matured and dry pods of *Delonix regia* (flamboyant) containing the seeds were collected from the annex campus of Nuhu Bamalli Polytechnic Zaria. The seeds were collected by opening the pods manually. The average seeds per pod was between 30-37, weight of 100 seeds was 42.5g. The collected seeds were hand picked for selection of healthy seeds.

Processing of Seeds

Seeds with identification number 1971 were weighed separately for processing, one part for cooking, the second for fermentation and the third left as raw.

Fermentation of *Delonix regia* (flamboyant) Seeds

The seeds were soaked in water for 12 hours. The drained soaked seeds were allowed to ferment naturally by tying in polythene bag and kept in a dark cupboard for 72 hours without the addition of yeast (Udensi and Okonkwo, 2006). The fermented seeds were allowed to dry for two days before grinding into homogenous powder using a hammer mill.

Cooking of *Delonix regia* (flamboyant) Seeds.

The seeds were boiled to 100 ^{o}C for 80 minutes and were allowed to cool and dried for two days and later ground to homogenous powder using a hammer mill (Bake et al., 2013).

Raw *Delonix regia* (flamboyant) Seeds

The raw seeds were dried for two days and were milled into a homogenous powder using a hammer mill.

Analysis of Differently Processed *Delonix Regia (*Flamboyant) Seeds

The differently processed seeds, cooked flamboyant seeds (CFS), fermented flamboyant seeds (FFS) and raw flamboyant seed (RFS) were taken for analysis of amino acid profile. All analysis was carried out in triplicates.

Determination of Amino Acid Profile of Raw and Processed *Delonix regia* (flamboyant) Seeds

The amino acid profile in the known sample was determined using the methods described by Benitez (1989). The known sample was dried to constant weight, defatted, hydrolysed,

evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-sample Amino Acid Analyser (TSM).

Defatting sample

The sample was defatted using chloroform/methanol mixture of ratio 2:1. 4g of the sample was put in extraction thimble and extracted for 15 hours in soxhlet extraction apparatus (Balogun et al., 2001).

Nitrogen determination

Two hundred milligramme (200mg) of ground sample was weighed, wrapped in Whatman filter paper (No. 1) and put in the kjeldahal digestion flask. 10ml of concentrated sulphuric acid was added. Catalyst mixture (0.5 g) containing sodium sulphate (Na_2SO_4), copper sulphate ($CuSO_4$) and selenium oxide (SeO_2) in the ratio of 10:5:1 was added into the flask to facilitate digestion. Four pieces of anti-bumping granules were added.

The flask was then put in kjeldahal digestion apparatus for 3hours until the liquid turned light green. The digested sample was cooled and diluted with distilled water to 100 ml in standard volumetric flask. Aliquot (10 ml) of the diluted solution with 10 ml of 45 % sodium hydroxide was put into the Markham distillation apparatus and distilled into 10 ml of 2 % boric acid containing 4 drops of bromocresol green/methyl red indicator until about 70 ml of distillate was collected.

The distillate was then titrated with standardized 0.01N hydrochloric acid to grey colour.

$$\text{Percentage Nitrogen} = \frac{(a-b)\times 0.01 \times 14 \times V \times 100}{W \times C}$$

Where;

a= Titre value of the digested sample

b= Titre value of blank sample

v= Volume after dilution (100ml)

W= Weight of dried sample (mg)

C= Aliquot of the sample used (10ml)

14= Nitrogen constant in mg

Hydrolysis of the Sample

A known weight of the defatted sample was weighed into glass ampoule. Seven (7) ml of 6NHCl was added and oxygen was expelled by passing nitrogen into the ampoule . This is to avoid possible oxidation of some amino acids during hydrolysis (e.g. methionine and cysteine). The glass ampoule was then sealed with Bunsen burner flame and put in an oven preset at 105^{o}C ± 5 ^{o}C for 22 hours. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humins. It should be noted that the tryptophan is destroyed by 6NHCl during hydrolysis. The filtrate was then evaporated to dryness in hot air oven. The residue was dissolved with 5ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles which were kept in the freezer.

Loading of the hydrolysate into TSM analyzer

The amount loaded was between 5 to 10 microliter. This was dispended into the cartridge of the analyzer. The TSM analyzer is designed to separate and analyze free acidic, neutral and basic amino acids of the hydrolysate. The period of an analysis lasted for 76 minutes.

Method of calculating Amino Acid Concentration

An integrator attached to the analyzer calculates the peak area proportional to the concentration of each of the amino acids which includes lysine, histidine, arginine, proline, glycine, alanine, cystine, valine, methionine, isoleucine, leucine, tyrosine and phenyalanine.

Statistical Analysis

Data obtained were subjected to one way analysis of variance (ANOVA) using general linear model (GLM of SAS 9.2). Duncan Multiple Range Test (DMRT) was used to test difference between levels of means and mean separation was considered significant at $P < 0.05$.

1. RESULTS AND DISCUSSION

Table 1 shows the amino acid profile of diets fed *H. bidorsalis* at different inclusion levels of raw *Delonix regia* seeds. All the essential amino acids (lysine, arginine, threonine, valine, methionine, isoleucine, leucine and phenylalanine) differs significantly at different inclusion levels among the treatments with the exception of histidine which was statistically similar ($P > 0.05$) across the dietary treatments. Lysine had the highest concentration (4.53 g/100g protein) in $RFSM_1$, while the least concentration (4.19g/100g protein) was observed in $RFSM_3$. $RFSM_1$ and $RFSM_2$ recorded the highest arginine content (6.53g/100g Protein and 6.45 g/100 g Protein) and were statistically similar ($P > 0.05$) but differs significantly ($P < 0.05$) from the control (6.10g/100g Protein) and $RFSM_3$ (5.16g/100g Protein). Threonine and valine recorded similar statistical trend with arginine. Methionine and leucine had the highest concentration in the control group (2.29g/100g Protein and 9.60g/100g Protein) which was statistically different from other treatments. $RFSM_1$ had the highest concentration of isoleucine (3.14g/100g Protein) and phenylalanine (4.17g/100g Protein) which differs statistically ($P < 0.05$) from other treatments.

Non-essential amino acid (Glutamic acid, serine, aspartic acid, proline, glycine, alanine, cystine and tyrosine) were statistically different ($P < 0.05$) among the treatments. $RFSM_1$, had the highest concentration of glutamic acid (12.87g/100g Protein) while the least concentration was observed in $RFSM_3$ (11.50g/100g Protein). $RFSM_1$ had the highest value for serine (3.59g/100g Protein), $RFSM_2$ was intermediate (3.43g/100g Protein) while the control (3.08g/100g Protein) and $RFSM_3$ recorded the lowest concentration (3.00g/100g Protein) and were statistically similar ($P > 0.05$). Aspartic acid was statistically different ($P < 0.05$) among the treatments with the exception of $RFSM_3$ (7.69g/100g Protein). $RFSM_1$ had the highest levels of proline (3.25g/100g Protein) and glycine content (3.32g/100g Protein) which differs significantly ($P < 0.05$) from $RFSM_2$ (3.14g/100g Protein and 3.25g/100g Protein), control (3.04g/100g Protein and 3.16 g/100 g Protein) respectively. $RFSM_1$ had the highest concentration for alanine (3.98g/100g Protein) which differs significantly ($P < 0.05$) from $RFSM_2$ (3.90g/100g Protein), control and $RFSM_3$ respectively, though the control and $RFSM_3$ were similar ($P > 0.05$). $RFSM_1$ had the highest level of cysteine (1.15g/100g Protein) which differs significantly from the control, $RFSM_2$ and $RFSM_3$ respectively. Tyrosine concentration was highest in $RFSM_1$ (2.75g/100g Protein) and $RFSM_2$ (2.75g/100g Protein) which differs statistically from control (2.41g/100g Protein) and $RFSM_3$ (2.41g/100g Protein) which were both statistically similar ($P > 0.05$).

Table 2 shows the amino acid profile of diets fed *H. bidorsalis* at different inclusion levels of fermented *Delonix regia* seeds. All the essential amino acids were statistically different ($P < 0.05$) among the treatment for lysine, arginine, threonine, valine, isoleucine, leucine and phenylalanine with the exception of histidine and methionine. $FFSM_1$ had the highest lysine content (4.85g/100g Protein), followed by $FFSM_2$ (4.77g/100g Protein), $FFSM_3$ (4.67g/100g Protein) and the control group (4.37g/100g Protein). $FFSM_1$ and $FFSM_2$ had the highest levels of

arginine (6.88 and 6.7g/100g Protein) while the control group recorded the least level (6.10 g/100g Protein).

$FFSM_1$, $FFSM_2$ and $FFSM_3$ recorded higher concentration of threonine which differs significantly from the control group (2.99g/100g Protein). $FFSM_1$ and $FFSM_2$ were statistically higher (4.24 and 4.1g/100g Protein) than $FFSM_3$ (4.09g/100g Protein) and the control (3.80g/100g protein) for valine concentration. $FFSM_1$ had the highest concentration (3.30 g/100g Protein) of isoleucine which was statistically different ($P < 0.05$) from $FFSM_2$ (3.21 g/100g Protein), $FFSM_3$ (3.21g/100g Protein) and the control treatment (2.94g/100g Protein). Leucine was highest (9.60g/100g Protein) in the control which differs statistically ($P < 0.05$) from other dietary treatments. $FFSM_1$ and $FFSM_2$ recorded the highest concentration (4.25g/100 g Protein) of phenylalanine which was statistically different ($P < 0.05$) from $FFSM_3$ (3.99g/100 g Protein) and the control diets (3.72g/100 g Protein). All the non-essential amino acids (glutamic acid; serine, aspartic acid, proline, glycine, alanine cysteine and tyrosine) were statistically different ($P < 0.05$) across the dietary treatments. $FFSM_1$ had the highest levels (13.47g/100g Protein) of glutamic acid which was statistically different ($P < 0.05$) from $FFSM_2$ (13.32g/100g Protein), $FFSM_3$ (13.17g/100g Protein) and the control (11.96g/100g Protein). $FFSM_1$, $FFSM_2$ and $FFSM_3$ were statistically higher ($P < 0.05$) than the control group (3.08g/100g Protein) in serine. $FFSM_1$ had the highest level of aspartic acid (8.18g/100g Protein) which was statistically different ($P < 0.05$) from $FFSM_2$ (8.09g/100g Protein) and $FFSM_3$ (8.06g/100g Protein) which were similar though higher than the control group (7.78g/100g Protein). Proline and glycine recorded similar trend for $FFSM_1$, $FFSM_2$ and $FFSM_3$ respectively and were statistically different ($P < 0.05$) from the control group. $FFSM_1$ and $FFSM_3$ had the highest levels of alamine (4.2g and 4.17g/100g Protein) and were statistically different ($P < 0.05$) from $FFSM_2$ (4.0g/100g Protein) and the

control group (3.79g/100g Protein). $FFSM_2$ had the highest cysteine concentration (1.27g/100g Protein) which differs statistically from control (1.09g/100g Protein), $FFSM_1$ (1.21g/100g Protein) and $FFSM_3$ (0.97g/100g Protein). Tyrosine level was higher in $FFSM_1$ (3.09g/100g Protein) which differs significantly ($P < 0.05$) across the dietary treatments. Amino acid profile of diets fed *H. bidorsalis* at different inclusion levels of cooked *Delonix regia* seeds are shown in Table 3. Essential amino acids concentration were statistically different ($P < 0.05$) across the dietary treatments. $CFSM_1$ had the highest lysine content while the least was recorded in the control diet (4.34g/100g Protein). $CFSM_1$ and $CFSM_2$ were statistically similar ($P > 0.05$) in the concentration of histidine but were significantly different ($P < 0.05$) from $CFSM_3$ and the control. $CFSM_1$ had the highest arginine content (7.31g/100g Protein) which was significantly different ($P < 0.05$) from $CFSM_1$ (3.24g/100g Protein), $CFSM_2$ (3.22g/100g Protein). Control had the highest leucine concentration (9.60g/100g Protein) which differs significantly ($P < 0.05$) among the treatments. $CFSM_1$ had higher level of phenylalanine content (4.43g/100g Protein) than the control (3.72g/100g Protein), $CFSM_2$ (4.25 g/100g Protein) and $CFSM_3$ (4.08g/100g Protein) respectively. Nonessential amino acids (glutamic acid, serine, aspartic acid, proline, glycine, alanine, cysteine and tyrosine) differs significantly ($P < 0.05$) among the treatments $CFSM_1$ recorded the highest concentration (14.31 g/100g Protein) of glutamic acid which differs significantly ($P < 0.05$) from $CFSM_2$ (14.23g/100 g Protein), $CFSM_3$ (13.32g/100g Protein). Serine had the highest concentration (4.10g/100g Protein) in $CFSM_1$ which was statistically different ($P < 0.05$) from other dietary treatments. $CFSM_1$ and $CFSM_2$ recorded the highest concentration of aspartic acid, proline and tyrosine which were statistically different ($P < 0.05$) from $CFSM_3$ and the control group. Glycine (3.5 g/100g Protein) and alanine (4.47g/100g

225 Protein) levels were highest in $CFSM_1$ which was statistically different from $CFSM_2$, $CFSM_3$
226 and the control.

227 **Table 1: Mean Amino Acid Profile of Raw *Delonix regia* Seeds Fed *H. bidorsalis* at**
228 **Different Inclusion Levels of Diet**

Amino acid (g/100gProtein)	0% (Control)	$RFSM_1$	$RFSM_2$	$RFSM_3$	SEM
EAA					
Lysine	4.34^{c}	4.53^{a}	4.45^{b}	4.19^{d}	0.014
Histidine	2.23^{a}	2.27^{a}	2.23^{a}	2.23^{a}	0.017
Arginine	6.10^{b}	6.53^{a}	6.45^{a}	5.16^{c}	0.031
Threonine	2.99^{b}	3.11^{a}	3.08^{a}	2.61^{c}	0.008
Valine	3.80^{b}	3.97^{b}	3.94^{b}	3.74^{c}	0.016
Methionine	2.29^{a}	2.19^{a}	2.19^{b}	2.19^{b}	0.018
Isoleucine	2.94^{c}	3.14^{a}	3.07^{b}	2.68^{d}	0.021
Leucine	9.60^{a}	6.94^{b}	6.59^{c}	5.25^{d}	0.034
Phenylalanine	3.72^{d}	4.17^{a}	4.08^{b}	3.81^{c}	0.018
NEAA					
Glutamic acid	11.96^{c}	12.87^{a}	12.72^{b}	11.50^{d}	0.032
Serine	3.08^{c}	3.59^{a}	3.43^{b}	3.00^{c}	0.034
Aspartic acid	7.78^{ab}	7.90^{a}	7.87^{a}	7.69^{b}	0.046
Proline	3.04^{c}	3.25^{a}	3.14^{b}	2.84^{d}	0.020
Glycine	3.16^{c}	3.32^{a}	3.25^{b}	3.08^{d}	0.021
Alanine	3.79^{c}	3.98^{a}	3.90^{b}	3.79^{c}	0.011
Cysteine	1.09^{b}	1.15^{a}	1.09^{b}	1.09^{b}	0.007
Tyrosine	2.41^{b}	2.75^{a}	2.75	2.41^{b}	0.020

229 ^{abcd} Means with different superscripts cross the groups differed significantly ($P<0.05$).

EAA - Essential amino acid

NEAA - Non- essential amino acid

Table 2: Mean Amino Acid Profile of Fermented *Delonix regia* Seeds Fed *H. bidorsalis* at Different Inclusion Levels of Diet

Amino acid (g/100gProtein)	0% (Control)	$FFSM_1$	$FFSM_2$	$FFSM_3$	SEM
EAA					
Lysine	4.34^{d}	4.85^{a}	4.77^{b}	4.67^{c}	0.014
Histidine	2.23^{a}	2.30^{a}	2.30^{a}	2.30^{a}	0.032
Arginine	6.10^{c}	6.88^{a}	6.79^{a}	6.62^{b}	0.038
Threonine	2.99^{b}	3.19^{a}	3.16^{a}	3.19^{a}	0.016
Valine	3.80^{c}	4.24^{a}	4.18^{a}	4.09^{b}	0.019
Methionine	2.29^{a}	2.21^{b}	2.21^{b}	2.21^{b}	0.017
Isoleucine	2.94^{c}	3.30^{a}	3.21^{b}	3.21^{b}	0.023
Leucine	9.60^{a}	7.79^{b}	7.50^{c}	7.18^{d}	0.043
Phenylalanine	3.72^{c}	4.25^{a}	4.25^{a}	3.99^{b}	0.017
NEAA					
Glutamic acid	11.96^{d}	13.47^{a}	13.32^{b}	13.17^{c}	0.015
Serine	3.08^{b}	3.81^{a}	3.81^{a}	3.78^{a}	0.023
Aspartic acid	7.78^{c}	8.18^{a}	8.09^{b}	8.06^{b}	0.016
Proline	3.04^{b}	3.25^{a}	3.25^{a}	3.25^{a}	0.018
Glycine	3.16^{b}	3.37^{a}	3.35^{a}	3.42^{a}	0.020
Alanine	3.79^{c}	4.21^{a}	4.09^{b}	4.17^{a}	0.019
Cysteine	1.09^{c}	1.21^{b}	1.27^{a}	0.97^{d}	0.016
Tyrosine	2.41^{c}	3.09^{a}	2.92^{b}	2.93^{b}	0.017

235 [abcd] Means with different superscripts across the groups differed significantly (P<0.05).

236 EAA - Essential amino acid

237 NEAA - Non- essential amino acid

238

Table 3: Mean Amino Acid Profile of Cooked *Delonix regia* Seeds Fed *H. bidorsalis* at Different Inclusion Levels of Diet

Amino acid (g/100gProtein)	0% (Control)	$CFSM_1$	$CFSM_2$	$CFSM_3$	SEM
EAA					
Lysine	4.34^{c}	5.17^{a}	5.04^{b}	5.09^{b}	0.016
Histidine	2.23^{b}	2.36^{a}	2.23^{a}	2.27^{b}	0.017
Arginine	6.10^{d}	7.31^{a}	7.14^{b}	6.54^{c}	0.036
Threonine	2.99^{c}	3.24^{b}	3.22^{b}	3.36^{a}	0.017
Valine	3.80^{c}	4.44^{a}	4.30^{b}	4.30^{b}	0.035
Methionine	2.29^{a}	2.21^{b}	2.19^{b}	2.24^{ab}	0.020
Isoleucine	2.94^{b}	3.40^{a}	3.34^{a}	3.30^{a}	0.032
Leucine	9.60^{a}	8.29^{b}	8.08^{c}	7.21^{d}	0.033
Phenylalanine	3.72^{d}	4.43^{a}	4.25^{b}	4.08^{c}	0.017
NEAA					
Glutamic acid	11.96^{d}	14.31^{a}	14.23^{b}	13.32^{c}	0.020
Serine	3.08^{c}	4.10^{a}	3.89^{b}	3.08^{c}	0.023
Aspartic acid	7.78^{c}	8.50^{a}	8.40^{a}	8.00^{b}	0.032
Proline	3.04^{c}	3.35^{a}	3.35^{a}	3.25^{b}	0.022
Glycine	3.16^{c}	3.56^{a}	3.39^{b}	3.34^{b}	0.021
Alanine	3.79^{c}	4.47^{a}	4.28^{b}	4.28^{b}	0.038
Cysteine	1.09^{b}	1.21^{ab}	1.27^{a}	0.90^{c}	0.040
Tyrosine	2.41^{c}	3.09^{a}	3.09^{a}	2.75^{b}	0.023

^{abcd} Means with different superscripts across the groups differed significantly ($P<0.05$).

EAA - Essential amino acid

NEAA - Non- essential amino acid

$CFSM_2$ and $CFSM_3$ were statistically similar ($P > 0.05$) for glycine and alanine, though significantly different from the control. $CFSM_1$ and $CFSM_2$ recorded significantly ($P < 0.05$) the highest concentration of cysteine (1.21g/100g Protein and 1.27g/100g Protein) which were statistically different ($P < 0.05$) from control (1.09 g/100g Protein) and $CFSM_3$ (0.90g/100g Protein). The raw, cooked and fermented *Delonix regia* seeds were rich sources of essential amino acids which make it a useful supplement for cereal grains which are generally low in these amino acids (Iyayi and Taiwo, 2003). The lower level of lysine (4.19- 5.17 g/100g cp) as compared to report of several researchers (Balogun et al., 2001) maybe due to reaction with oxidized lipids (Findley and Ludin, 1980). Highest digestibility of amino acids observed in cooking as a processing method in this study could be linked to break down of the proteinaceous toxins such as typsin inhibitors and haemaglutinins (Liener, 1980) and down regulation of sulphur containing compounds which enhance the high digestibility of amino acids. All the range observed in this study for both essential and non- essential amino acids in *Delonix regia* seeds were higher than the minimum recommended levels of (NRC, 1993) for amino acids in diets. The range of proline contents (2.84 – 3.35g/100g cp) in the analyzed samples of *Delonix regia* seed meal are notably lower than the values reported in literature (4.02 g/g cp). The increase in amino acid content in the fermented *Delonix regia* seed meal as compared to the raw *Delonix regia* seed meal could be linked to the higher ability of hydrolyzing the antinutritional components during fermentation which will then allow more release of amino acids.

CONCLUSION

Essential and non-essential amino acid concentrations were higher in the cooked *Delonix regia* seeds than the fermented *Delonix regia* seeds. Cooking of *Delonix regia* seeds at 10% inclusion levels had the highest activities of essential and non-essential amino acids.

REFERENCES

1. Balogun, T. F., Kaankuka, F. G. and Bawa, G. S. (2001). Effect of period of boiling full fat soyabeans on its amino acid profile and on performance on pigs. *Nigerian Journal of Animal Production*, 28: 45 – 51.
2. Benitez, L. V. (1989). Amino acid and falty acid profile in aquaculture nutrition studies. 23 – 35, In: S. S. De Silva (ed). Fish Nutrition Research in Asia. Proceedings of the third Asian Fish Nutrition Network Meeting. Asian Fisheries Society Special Publication. Asian Fishery Society, Manila Philippines, 4(1): 166-169..
3. Deng, J., X. Zhang, B. Bi, L. Kong, B. Kang, 2011. Dietary protein requirement of juvenile asian red-tailed catfish Hemibagrus wyskioides, Animal feed Sci.and Tech, 170:231-238.[8]
4. Fagbenro, O., 1998. Short communication apparent digestibility of various oil seed cakes/meals in African catfish diets, Aquaculture Int., 6:317-322
5. Findley, J. W and Ludin, R. E. (1980). Lipid hydro- peroxide induced oxidation of cysteine in protein. *Journal of Science,* 33: 165 – 172.
6. Iyayi, E. A and Taiwo, V. O (2003). The effects of diets incorporating *Mucuna* (*M. pruriens*) seed meal on the performance of laying hens and broilers. *Tropical Subtropical Agro Ecosystem*, 1: 239 – 246.
7. Liener, E. I. (1980). Toxic factors in edible legumes. *American Journal of Clinical Nutrition*, 2:281-284.
8. NRC (1993). Nutrients requirements of fish. National Academy Press, Washington DC. 3-6.
9. Pandey, G., 2013. Feed formulation and feeding technology for fishes, Int. Res. J. Pharm, 4(3): 23-29.[7]
10. Tiamiyu, L.O., G.A. Ataguba, J.O. Jimoh, 2013. Growth performance of Clarias gariepinus fed different levels of agama agama meal diets, Pakistan J.of Nutrition, 12(5):510-515.
11. Udensi, E. A. and Okoronkwo, K. A. (2006). Effects of fermentation and germination on the Physico-chemical properties of Mucuna cochinchnensis protein isolates. African Journal of Biotechnology, 5(10): 896 – 900.