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Research Article

Chicken Amino Acid and Fatty Acid: Effect of Feeding Taro Leaf in the Diet

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Abstract

The objective of this study is designed to investigate the amino acid and fatty acid composition of broiler feed containing taro leaf and chicken meat samples. The amino acid and fatty acid composition (%) of both feed and meat samples were quantified with their relative area comparing with the respective standards. In the present study, the dominant essential amino acid in breast muscle is leucine, lysine and valine ranging from 62.99 ± 0.04 to 66.43 ± 0.32, 71.92 ± 0.04 to 75.36 ± 0.3 and 39.99 ± 0.32 to 43.43 ± 0.04 in T_4 and T_1, respectively. The dominant fatty acid in percentage is palmitic acid ($C_{16:0}$) ranging from 13.58 to 46.79. The next three dominant fatty acids are oleic acid ($C_{18:1, n\text{-}9}$), linoleic acid ($C_{18:2, n\text{-}6}$) and stearic acid ($C_{18:0}$) which ranged from 21.74 to 32.1, 17.15 to 35.35 and 4.82 to 15.3 (%) values, respectively. From the proportion (mg/100 g) of saturated, monounsaturated and polyunsaturated fatty acids, the unsaturated fatty acids are of very high concentration in taro leaf containing broiler feed than those saturated fats. From the findings of this study, as the incorporation of taro leaf in the feed rations from 3 - 7%, the amino acid and fatty acid composition improved in chicken meat and therefore the study is found to be very significant for future use of taro leaf in chicken diet formulation so as to improve mainly the limiting amino acids and unsaturated fatty acid in the feed and as well as in the chicken meat.

Keywords: Amino Acid; Fatty Acid; Chicken Meat; Taro Leaf

Introduction

Poultry feed formulation involves the wise use of feed ingredients to supply adequate amounts and proportions the nutrient required by the birds. In developing countries, chicken production is the best alternative form of income generation, plays a significant role in family nutrition and above all, smallholder poultry provides a good opportunity to address poverty alleviation [1,2]. It is generally assumed that improvements in alternative feed sources will be associated with increased rate of productivity and product quality [3,4]. However, the poultry rations become costly and scarcity of conventional feedstuffs challenged the supply high nutrients chicken meats for the consumers. Due to this fact, most of poultry feed is made of cereals and lack the most important amino acids for humans, such as lysine, threonine, the sulphur-bearing amino acids (methionine and cysteine) and occasionally tryptophan unless supplemented in the ration [5]. The supply of such amino acids in the feed is very expensive and beyond the rich of poultry farmers. Since this is a great problem in nutrition and that is why important to identify alternative high quality protein feed ingredients that contain most of essential amino acids [6].

For the nutrient density and composition analysis, it is impractical to analyses each item of the ingredients for nutrient contents [7]. Dietary amino acid density has been evaluated as a way to optimize the nutrient requirements by the poultry. In previous works in Ethiopia, an attempt was made known about poultry feed nutrient composition of different conventional and non-conventional types of feed. However, no research is conducted on amino acid and fatty acid profiling of the feed as well as poultry products due to lack of analytical facilities a lack of awareness on nutritional and economic benefits [8]. Moreover, researchers have not evaluated the effects of amino acid, dense feed on the growth of birds and meat quality. Since, the amino acid and fatty acid profile analysis in food are recently developed, which have currently gained attention by researchers [9,10]. The present study, therefore aimed at analyzing the amino acid and fatty acid profile of both broiler feed and chicken meat. Due to the emphasis placed on both nutritional and health importance of food by consumers, a great need exists for information on the nutritional contents of the feed [11]. The analysis of amino acid and fatty acid composition is an essential part of nutrition studies and important to know the overall nutritional qualities [12,13]. Investigation is warranted regarding dietary amino acid and fatty acid of feed and end products. To this effect taro can be a possible alternative feed ingredients in this regard and utilisation of cheap and readily available feed ingredient is important in maximizing nutrient and economic value [5].

This study brings extensive research outputs on how to use taro leaves taro leaf in poultry production [14]. The study also aimed to evaluate the amino acid and fatty acid composition in broiler rations and chicken meat.

Objectives

General Objective

The general objective of the study is to investigate whether taro leaf could enrich chicken meat with amino and fatty acids

Specific Objectives

- To determine the amino acid and fatty acid profile of the feed containing taro leaf.
- To determine the amino acid and fatty acid profile of chicken meat.

Materials and Methods

Sample Source and Laboratory Analysis

Broiler chicks were randomly divided into four dietary treatments and fed rations containing different levels of taro leaf (TL) for 56 days. At the end of the experiment, 2 randomly selected birds from each treatment were starved for 12 hours and slaughtered by severing the neck then dry de-feathered by hand plucking. Birds were eviscerated and breast muscle cuts were taken, freeze dried and ground to powder. Both the feed and meat samples tested for fatty acid and amino acid composition using Gas Chromatography-Flame Ionization Detector (GC-FID) and Ultra High Pressure Liquid Chromatography-Fluorescence detector (UHPLC), respectively.

Amino Acid Analysis Protocol

Samples of feed and meat were digested in acid and alkaline medium to the complete hydrolysis of the protein fraction. Briefly, 100 mg of each sample were digested with 3 ml of 6 N HCl at 200^{0}C in heated oven for 24 hours after sealing tubes with nitrogen gas to prevent oxidation. The digested samples were filtered with Whatman No. 6 and the filtrates were evaporated at 100^{0}C water bath for removing the chlorine gas. Hydrolyzed protein was completely dry with nitrogen gas and re-constituted with 200 µl (0.2 ml) of

0.1N HCl. For Tryptophan, alkaline hydrolysis was used and 50 mg of each feed and meat samples were suspended in 20 ml of 3N-NaOH and sealed under N2 gas and hydrolyzed for 3 hours at 110^0C heating oven [15].

Following hydrolysis, centrifuged for 10 minutes at 4,000 RPM and then supernatant was taken and diluted with 50 folds with water (milliq water). Then the final acid and alkaline hydrolyzates were filtered (0.2 µm) and inject into UHPLC system using MPA/OPA/FMOC derivatization protocol. Mercaptopropionic acid (MPA) used as catalyst, o-Phthaldialdehyde (OPA) and Fluorenylmethyl chloroformate (FMOC) used as reagents for primary and secondary amines derivatization, respectively.

UHPLC instrumentation and analytical procedure: Amino acid analysis was conducted with the Shimadzu UHPLC system (Shimadzu, Columbia, MD). Derivatization was taken automatically by the instrument using o-Phthaldialdehyde (OPA) for all primary amino acids and Fluorenylmethyl chloroformate (FMOC) for secondary amino acids (Proline and Hydroxyproline). The UHPLC system consisted of a binary pumping system: pump A (LC-10AD VP) and pump B (LC-10AT VP), a degasser (DGU-14A), an Autosampler (SIL-20AC HT), column heater (Brinkmann, CH-30) and Fluorescence detector and system controller (CBM-20A). Mobile phase A was a mixture of Sodium hydrogen phosphate (Na_2HPO_4), hydrated sodium borate ($Na_2B_4O_7$) and Sodium azide (NaN_3) while mobile phase B was acetonitrile/methanol/water (45/45/10 v/v/v).

The separation was obtained at a flow rate of 2 ml/min with a gradient program that 0.01 minute (1% B), 7.4 minutes (40% B), 10 minutes (45% B), 10.1 (100% B). Then washing at 100% B and calibration at 0% B was performed in a total analysis time of 12.1 minutes (Carl, 2015). In order to quantify amino acids, the mix standard was used from Asparagine, Alanine, Arginine, Aspartic acid, Cystine, Glutamic acid, Glutamine, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Serine, Tyrosine, Valine, Proline, Tryptophan, Cysteine, Norleucine and Hydroxyproline were prepared and used for easy identification of peaks in the mix as well as their individual amino acid standards. Before real sample analysis, the UHPLC was tested for linearity, precision and limit of quantification (LOQ), selectivity and resolution by spiking amino acid standards [16].

Fatty acid analysis protocol

Lipids from feed and meat samples were extracted with hexane-isopropanol (3:2 v/v) with a modified method adapted from a previous study [17]. Approximately 1g of each sample was used in the duplicates and placed in a glass tube with 10 ml hexane-isopropanol (HIP) (Sigma, USA) and homogenized for 3*30 seconds (5411 g) (ULTRA-TURRAX T25, IKA). The Homogenizer was rinsed with HIP between samples. The homogenate was then quantitatively transferred to teflon centrifuge tubes using 5 ml HIP and 6.5 ml Na_2SO_4 (6.67% w/v). Samples were centrifuged at 4000 RPM, 18°C, for 5 minutes, after which the upper phase was removed to pre-weighed evaporation tubes using glass Pasteur pipettes. One millilitre of hexane was added to the centrifuge bottle and centrifugation was repeated. The upper phase from both centrifugations were then combined and evaporated at 40°C with N_2 flushing for approximately 40 minutes until dried. Evaporation tubes were re-weighed and the amounts of fat extracted were calculated. Another 0.5 ml hexane was added into the evaporation tubes, rinsed and transferred to the small glass tube. Teflon tape was used, then the samples were vortexed and stored in a freezer at -18°C.

Methylation: The concentration of lipids dissolved in hexane was calculated before methylation, by microbalance weighing (Metller type UMT2, Switzerland). The methylation of fatty acids was done using a modified method [17]. Based on the microbalance lipid concentrations, required volumes of lipid solutions with 2 mg content were transferred to glass tubes with 2 ml methanol and 15 µL standard fatty acid solution (STD) (C17:1), where STD (1.44 µg/µL) was used as an internal standard for gas chromatography. The glass tubes were vortexed and incubated in a heating block at 60°C for 10 minutes. Three milliliters of BF_3 were added to tubes and followed by incubation under the same conditions. Afterwards, the samples were cooled in ice box for 15 minutes, after which 2 ml 20% NaCl and 2 ml hexane were added. After 10 second vortexing, the tubes were stored at 4°C for 20 minutes. The upper phase was transferred to a small glass vial with Pasteur pipettes and again stored at 4°C for 20 minutes. Transfer of the upper phase was repeated once more with 1 ml hexane added to the tube. The tubes were evaporated at 40°C with N_2 gas until dried (approximately 20 minutes). Finally, 300 µl aliquots of lipids were transferred into test tubes and kept at -18°C until GC analysis.

Thin layer chromatography (TLC) checking: The methylation was checked on a TLC silica plate. A solvent was made of hexane-diethyl ether acetic acid (85:15:1, v: v: v) one hour before using. Then the silica plate was prepared, by drawing a line with a lead pencil and mark out 7 dots plus a standard dot to show where to put the samples. Thereafter the methylated samples and the standard were vortexed and applied (3 µl) to the silica plate. The TLC plate was placed in the chamber for one hour (with the solvent in the bottom of the chamber). After one hour the silica plate was taken up, and dried by leaning it towards the chamber for approximately 20 minutes. Thereafter the silica plate was put down into a chamber with iodine and then it was left standing there for another 20 minutes. The fatty acid methyl esters were recognized by comparison to the standard TLC mixture.

GC-FID instrumentation and analytical procedure: Fatty acids were analyzed with a Gas Chromatography-Flame Ionization Detector (GC-FID) system (Varian CP-3800, Sweden) with a flame ionization detector (FID) equipped with a 50 m*0.22 mm inner diameter, 0.25 µm film DB-5 fused capillary column (Agilent Technologies, USA). The column temperature was programmed to

initiate at 158°C for 5 minutes and increased by 2°C/minute up to 220°C and remained for 8 minutes. The makeup gas was nitrogen and carrier gas was helium (0.8 ml/ min). The injector and detector temperatures were 230 and 250°C, respectively. Fatty acids were analyzed by comparing with the standard fatty acid solution (STD) and retention time. Chromatograms were analyzed using Galaxie chromatography data system software version 1.9 (Varian AB, Sweden).

Statistical analysis

The amino acid and fatty acids were first quantified and mean values were analyzed using the general linear model procedures of Statistical Analysis Systems software (version 9.4 SAS, 2002 Institute Inc., Cary, USA) [18,19]. Probability values at $P \leq 0.05$ were considered as significant. The differences in composition between the treatments were determined by analysis of variance (ANOVA).

Results and Discussions

As summarized in table 1, the amino acid composition in (g/100g) of the analyzed chicken breast meat samples were quantified with their relative area comparing with amino acid standard and the concentration of each amino acid (g/100g) was also calculated by multiplying the percentage of each amino acid with their average crude protein content. The dominant essential amino acid in breast muscle is leucine, lysine and valine ranging from (62.99 ± 0.04 to 66.43 ± 0.32), (71.92 ± 0.04 to 75.36 ± 0.3) and (39.99 ± 0.32 to 43.43 ± 0.04) in T4 and T1 respectively. Similarly, glutamic acid, aspartic acid and arginine are also the three dominant non-essential amino acid ranging from (104.53 ± 0.04 to 107.97 ± 0.04), (74.18 ± 0.04 to 77.62 ± 0.04) and (58.4 ± 0.3 to 61.84 ± 0.12) in T_4 and T_1 respectively.

Types of Amino Acids		Treatments			
Essential Amino Acids (EAA)	**Abbreviations**	**T_1**	**T_2**	**T_3**	**T_4**
L-Histidine	His	38.62 ± 0.32	39.29 ± 0.43	40.74 ± 0.23	42.06 ± 0.43
L-Isoleucine	Iso	36.48 ± 0.04	37.15 ± 0.3	38.6 ± 0.43	39.92 ± 0.34
L-Leucine	Leu	62.99 ± 0.04	63.66 ± 0.32	65.11 ± 0.04	66.43 ± 0.32
L-Lysine	Lys	71.92 ± 0.04	72.59 ± 0.04	74.04 ± 0.04	75.36 ± 0.3
L-Methionine + cys	Met-Cys	14.97 ± 0.32	15.64 ± 0.45	17.09 ± 0.44	18.41 ± 0.45
L-Phenylalanine	Phe	19.1 ± 0.04	19.77 ± 0.21	21.22 ± 0.34	22.54 ± 0.45
L-Threonine	Thr	30.75 ± 0.32	31.42 ± 0.43	32.87 ± 0.04	34.19 ± 0.04
L-Tryptophan *	Try	29.4 ± 0.04	30.07 ± 0.13	31.52 ± 0.43	32.84 ± 0.04
L-Valine	Val	39.99 ± 0.32	40.66 ± 0.04	42.11 ± 0.24	43.43 ± 0.04
Non-essential Amino Acids (NEAA)	**Abbreviations**	**T_1**	**T_2**	**T_3**	**T_4**
L-Alanine	Ala	43.33 ± 0.54	44 ± 0.65	45.45 ± 0.56	46.77 ± 0.12
L-Arginine	Arg	58.4 ± 0.3	59.07 ± 0.54	60.52 ± 0.56	61.84 ± 0.12
L-Asparagines	Asp	34.13 ± 0.04	34.8 ± 0.56	36.25 ± 0.56	37.57 ± 0.04
L-Aspartic acid	Asp	74.18 ± 0.04	74.85 ± 0.53	76.3 ± 0.04	77.62 ± 0.04
L-Glutamic acid	Glu	104.53 ± 0.04	105.2 ± 0.54	106.65 ± 0.56	107.97 ± 0.04
L-Glutamine	Glu	34.78 ± 0.04	35.45 ± 0.65	36.9 ± 0.04	38.22 ± 0.23
L-Glycine	Gly	31.65 ± 0.04	32.32 ± 0.56	33.77 ± 0.54	35.09 ± 0.23
L-Serine	Ser	24.78 ± 0.04	25.45 ± 0.43	26.9 ± 0.04	28.22 ± 0.32
L-Tyrosine	Tyro	29.4 ± 0.32	30.07 ± 0.04	31.52 ± 0.04	32.84 ± 0.22
L-Hydroxyproline	Hyd	13.22 ± 0.32	13.89 ± 0.04	15.34 ± 0.04	16.66 ± 0.54
L-Norleucine	Nor	14.19 ± 0.34	14.86 ± 0.04	16.31 ± 0.04	17.63 ± 0.54
L-Proline	Pro	13.97 ± 0.34	14.64 ± 0.04	16.09 ± 0.45	17.41 ± 0.54

Table 1: Amino acids composition (g/100 g) of chicken breast meat after feeding taro leaf (TL).

*: Alkaline Hydrolysed; AAs: Amino acids; T1: Ration Containing 0%TL; T2: Ration Containing 3% TL; T3: Ration Containing 5% TL; T4: Ration Containing 7% TL and TL: Taro Leaf; EAA: Essential Amino Acid and NEAA: Non-Essential Amino Acid.

In the present study, amino acid composition of chicken meat is affected by dietary supplementation with TL and similarly Fujimura and Kadowaki (2006) reported the amino acid composition of meat could be improved and varied due to dietary components. In general, the study concluded that the amino acid composition of chicken meat varied by feed ingredients and therefore, the findings of this study are found to be in agreement with the previous research works [20,21]. From the findings of this study, as an increasing taro leaf in the feed rations from 3-7%, the amino acid composition also increased in chicken meat and therefore the study is found to be very significant for future use of taro leaf in chicken diet formulation so as to improve mainly the limiting amino acids of the feed and final meat products as reported [21].

Table 2 summarizes the total fatty acid composition (%) for chicken breast meat samples. Fatty acids were identified with their retention time and quantified with relative area computing. The overall breast meat fatty acid of the TL is significantly different ($P <$

0.05). The dominant fatty acid in percentage is palmitic acid ($C_{16:0}$) ranging from (13.58 to 46.79) for T_1 and T_2. The next three dominant fatty acids are oleic acid ($C_{18:1, n-9}$), linoleic acid ($C_{18:2, n-6}$) and stearic acid ($C_{18:0}$) and ranging from 21.74 to 32.1, 17.15 to 35.35 and 4.82 to 15.3 (%) values, respectively. In the present study, quantified fatty acids of breast meat are affected by dietary supplementation with TL compares with and the control feed.

Class of Fatty Acids	T_1	T_2	T_3	T_4
$C_{16:0}$	13.58^{d}	46.79^{a}	31.85^{b}	15.05^{c}
$C_{16:1(n-7)}$	1.76^{c}	3.92^{a}	2.85^{b}	3.27^{ab}
$C_{18:0}$	7.11^{b}	4.82^{c}	15.3^{a}	8.84^{b}
$C_{18:1(n-9)}$	25.47^{b}	21.74^{c}	25.08^{b}	32.1^{a}
$C_{18:2(n-6)}$	35.35^{a}	17.15^{c}	17.22^{c}	25.31^{b}
$C_{18:3(n-3)}$	0.79^{a}	0.02^{ab}	0.75^{a}	0.8^{a}
$C_{20:1(n-9)}$	0.42^{a}	0.02^{ab}	0.31^{ab}	0.52^{a}
$C_{20:2(n-6)}$	0.77^{a}	0.02^{ab}	0.24^{ab}	0.77^{a}
$C_{20:3(n-6)}$	1.03^{a}	0.02^{ab}	0.61^{ab}	1.26^{a}
$C_{20:4(n-6)}$	0.02^{a}	0.02^{a}	0.02^{a}	0.02^{a}
$C_{22:6(n-3)}$	1.21^{a}	0.02^{b}	0.49^{ab}	1.27^{a}
Proportion (%), SFA, MUFA, PUFA and UFA:SFA				
SFAs	43.25	51.73	48.07	21.39
MUFA	28.09	27.27	28.45	36.3
PUFA	50.97	21.44	23.91	39.04
UFA	79.06	48.71	52.36	75.34
UFA:SFA	3.7	0.94	1.09	3
Total FA	79.31	100.44	100.43	96.73

Table 2: Fatty acid composition (%) of chicken breast meat samples after feeding taro leaf (TL).

a-c Means within a row with same superscripts did not differ significantly (P > 0.05; SFAs: Saturated Fatty acids; MUFAs: Monounsaturated Fatty acids; PUFAs: Polyunsaturated Fatty acids; UFAs: Unsaturated Fatty acids; T1: ration containing 0%TL; T2: ration containing 3% TL; T3: ration containing 5% TL; T4: ration containing 7% TL and TL: taro leaf meal.

Similar observations have been made by Cortinas., *et al.* [22] and Osek., *et al.* [23] that the muscle fatty acid compositions in broilers were affected by a variety of diets. The fatty acid compositions of breast muscles obtained in the present study are in agreement with values reported for broiler meat [22,24].

From the proportion (% of total fatty acids) in the present study, TL in broiler diets is not significantly affected the ratio between unsaturated fatty acid (UFA) and saturated fatty acids (SFA) (Table 2). In general, the UFAs is of very higher concentration than those SFAs. The possible reason might be included of TL containing UFAs increased UFAs in the breast meat. Thus, additive supplementation of TL up to 7% improved the UFAs profile of breast meat. These results are in agreement with other studies showing that improvement of UFAs in feed also increased the UFAs contents of breast muscle [25]. Therefore, inclusion of TL up to 7% in feed is advantageous to improve the UFA profile of chicken meat, because one of the criteria for the determination of fat quality is the content of essential UFA like linoleic, linolenic, and arachidonic acids [26,27].

The role of fatty acids, especially the polyunsaturated fatty acids (PUFAs) in the management of coronary heart disease can be considered as the function of fatty acids of plant origin [26,28]. Since, the presence of high levels of unsaturated fatty acids, of the total lipids is nutritionally desirable [29-31].

Table 3 summarizes the amino acid profile (g/100g) of broiler feed samples containing taro leaf. The calculated values are close, but are slightly higher in ration containing 7% TL. The increase in essential amino acid compositions is found as increasing the TL level in rations and the control feed is found to be the lowest in amino acid profile. The dominant essential amino acid in TL containing feed is leucine, lysine and valine ranging from 9.72 ± 0.32 to 10.56 ± 0.23, 7.42 ± 0.43 to 8.26 ± 0.32 and 7.12 ± 0.32 to 7.96 ± 0.43 in T_1 and T_4 respectively. Similarly, glutamic acid and aspartic acid are the two dominant non-essential amino acids ranging from 15.08 ± 0.23 to- 15.57 ± 0.43 and 13.78 ± 0.23 to 14.27 ± 0.43 in T_1 and T_4 feeds, respectively.

Types of Amino Acids		Treatments			
Essential Amino Acids	**Abbreviations**	T_1	T_2	T_3	T_4
L-Histidine	His	3.82 ± 0.21	4.03 ± 0.43	4.33 ± 0.23	4.66 ± 0.32
L-Isoleucine	Iso	6.02 ± 0.23	6.23 ± 0.24	6.53 ± 0.23	6.86 ± 0.23
L-Leucine	Leu	9.72 ± 0.32	9.93 ± 0.32	10.23 ± 0.24	10.56 ± 0.23
L-Lysine	Lys	7.42 ± 0.43	7.63 ± 0.24	7.93 ± 0.43	8.26 ± 0.32
L-Methionine + cys	Met-Cys	4.92 ± 0.23	5.13 ± 0.2	5.43 ± 0.43	5.76 ± 0.32
L-Phenylalanine	Phe	6.92 ± 0.32	7.13 ± 0.43	7.43 ± 0.32	7.76 ± 0.23
L-Threonine	Thr	5.92 ± 0.32	6.13 ± 0.32	6.43 ± 0.21	6.76 ± 0.32
L-Tryptophan *	Try	3.52 ± 0.23	3.73 ± 0.43	4.03 ± 0.32	4.36 ± 0.23
L-Valine	Val	7.12 ± 0.32	7.33 ± 0.32	7.63 ± 0.24	7.96 ± 0.43
Non-essential Amino Acids	**Abbreviations**	T_1	T_2	T_3	T_4
L-Alanine	Ala	8.48 ± 0.43	8.58 ± 0.23	8.75 ± 0.43	8.97 ± 0.34
L-Arginine	Arg	8.38 ± 0.43	8.48 ± 0.32	8.65 ± 0.44	8.87 ± 0.53
L-Asparagines	Asp	10.28 ± 0.23	10.38 ± 0.34	10.55 ± 0.43	10.77 ± 0.43
L-Aspartic acid	Asp	13.78 ± 0.23	13.88 ± 0.33	14.05 ± 0.43	14.27 ± 0.43
L-Glutamic acid	Glu	15.08 ± 0.23	15.18 ± 0.32	15.35 ± 0.34	15.57 ± 0.43
L-Glutamine	Glu	10.08 ± 0.23	10.18 ± 0.32	10.35 ± 0.43	10.57 ± 0.34
L-Glycine	Gly	6.09 ± 0.43	6.19 ± 0.32	6.36 ± 0.44	6.58 ± 0.34
L-Hydroxyproline	Hyd	8.98 ± 0.33	9.08 ± 0.34	9.25 ± 0.43	9.47 ± 0.43
L-Norleucine	Nor	9.98 ± 0.43	10.08 ± 0.34	10.25 ± 0.34	10.47 ± 0.54
L-Proline	Pro	9.37 ± 0.32	9.47 ± 0.34	9.64 ± 0.43	9.86 ± 0.43
L-Serine	Ser	10.98 ± 0.23	11.08 ± 0.43	11.25 ± 0.44	11.47 ± 0.45
L-Tyrosine	Tyro	7.08 ± 0.34	7.18 ± 0.34	7.35 ± 0.33	7.57 ± 0.32

Table 3: Amino acid profile (g/100g) of broiler feed containing different level of taro leaf (TL).

*: Alkaline Hydrolysed; TL: Taro Leaf; T1: Ration Containing 0% TL; T2: Ration Containing 3% TL; T3: Ration Containing 5% TL and T4: Ration Containing 7% TL; EAA: Essential Amino Acid and NEAA: Non-Essential Amino Acid.

In the present study, the result showed a positively increased amino acid content and found to be very significant that the use of TL in chicken diet formulation so as to supply the most limiting amino acid like leucine, lysine, methionine, tryptophan and Valine in chicken feed and chicken meat. For this, TL can be used as a protein source in chicken diets. This protein content is of particular nutritional significance as reported [32]. Diets rich in amino acids help to boost the immune system of the animals and the protein quality of the final products [33].

Therefore, the findings of this study are in agreement with the works of Ayuk [34]; Nguyen and Ogle (2005) and taro leaf can be good protein sources for feed formulation. Formulation of feeds from ingredients with a better amino acid profile will be more advantageous because it can decrease the use of most scares and expensive human food items for chicken [35,36]. This will also decrease the cost of feed and chicken products.

Table 4 summarizes the fatty acid profile (mg/100g) of feed samples containing TL. The overall fatty acids are significantly different ($P < 0.05$). The dominant fatty acid in all feed sample is linoleic acid ($C_{18:2, n-6}$) ranging from 81.642 ± 0.02 to 240.585 ± .05 (%). The next three dominant fatty acids are oleic acid ($C_{18:1, n-9}$), palmitic acid ($C_{16:0}$) and α-linolenic acid ($C_{18:3, n-3}$) ranging from 12.810 ± 0.03 to 99.502 ± .045, 68.646 ± 0.04 to 88.463 ± .023 and 18.495 ± 0.04 to 170.686 ± 0.04(%) values, respectively. The T_4 and T_3 have a better fatty acid fraction of C_{18} and C_{16} than feed samples containing different TL and the least C_{18} and C_{16} fatty acid composition observed in control feed. The fatty acid compositions of feed in the present study are in agreement with the findings reported by [37,38].

Class of Fatty Acids	Treatments			
	T_1	T_2	T_3	T_4
$C_{16:0}$	88.463 ± .023^{c}	109.158 ± .04^{b}	70.007 ± .034^{d}	68.646 ± .04^{d}
$C_{16:1(n-7)}$	1.501 ± .032^{c}	6.340 ± .043^{ab}	1.086 ± .034^{c}	1.065 ± .043^{c}
$C_{18:0}$	15.254 ± .034^{d}	22.601 ± .043^{b}	20.520 ± .03 ^{b}	20.121 ± .05^{bc}
$C_{18:1(n-9)}$	12.810 ± .034^{d}	19.711 ± .043^{c}	101.475 ± .043^{b}	99.502 ± .045^{b}
$C_{18:2(n-6)}$	81.642 ± .023^{d}	101.094 ± .043^{c}	245.354 ± .034^{b}	240.585 ± .05^{b}
$C_{18:3(n-3)}$	140.502 ± .023^{b}	170.686 ± .043^{a}	18.862 ± .024^{c}	18.495 ± .045^{c}
$C_{20:1(n-9)}$	0.070 ± .021^{c}	4.648 ± .043^{a}	0.663 ± .032^{b}	0.651 ± .04^{b}
$C_{2<0:2(n-6)}$	0.070 ± .012^{cd}	4.648 ± .032^{a}	0.093 ± .034^{c}	0.091 ± .012^{c}
$C_{20:3(n-6)}$	5.707 ± .012^{b}	11.313 ± .034^{a}	0.093 ± .043^{c}	0.091 ± .012^{c}
$C_{20:4(n-6)}$	0.070 ± .012^{c}	4.648 ± .03^{a}	0.093 ± .04^{c}	0.091 ± .02^{c}
C22:6(n-3)	0.070 ± .023	4.648 ± .03 ^{a}	2.115 ± .034 ^{b}	2.074 ± .023 ^{b}
Proportion (mg/100 g), SFA, MUFA, PUFA and UFA:SFA				
SFA	106.94	162.96	94.26	92.42
MUFA	15.92	50.78	105.26	103.21
PUFA	229.61	298.87	266.61	261.43
UFA	245.53	349.65	371.87	364.64
UFA:SFA	2.29	2.14	3.94	3.94
Total FA	352.47	512.61	466.13	457.06

Table 4: Fatty acid profile (mg/100g) of broiler feed containing different level of taro leaf (TL). SFAs: Saturated Fatty acids; MUFAs: Monounsaturated Fatty acids; PUFAs: Polyunsaturated Fatty acids; UFAs: Unsaturated Fatty acids; T1: Ration Containing 0% TL; T2: Ration Containing 3% TL; T3: Ration Containing 5% TL and T4: Ration Containing 7% TL.

Feed containing TL at 5 and 7% have shown a better UFA content than the control (Table 4). In general, the unsaturated fatty acids did increases the TL level increased. The results of the present study agreed with other studies showing that the inclusion of feed sources rich in unsaturated fatty acids also increased the unsaturated fatty acid contents of the feed and consequently the animal product [39]. Thus, additive inclusions of TL up to 7 % of the positively increased the unsaturated fatty acid profile of the feed. These findings are in agreement with the works of [27,40].

Conclusions

To conclude the amino acid and fatty acid composition of chicken meat and feed containing taro leaf from this study, the essential amino acid profiles, leucine, lysine and valine dominantly found both in the breast meat and the feed respectively. For fatty acid profile, palmitic acid ($C_{16:0}$) oleic acid ($C_{18:1,\ n-9}$), linoleic acid ($C_{18:2,\ n-6}$) and stearic acid ($C_{18:0}$) dominantly found both in the breast meat and the feed respectively. The GC-FID and UHPLC instrumentations are found to be an efficient method for fatty acid and amino acid analysis. From the findings of this study, as the incorporation of taro leaf in the feed rations from 3 - 7%, the amino acid and fatty acid composition improved in chicken meat and therefore the study is found to be very significant for future use of taro leaf in chicken diet formulation so as to improve mainly the limiting amino acids and unsaturated fatty acid class in the feed and as well as in the chicken meat.

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Conflict of Interest

There is no personal, financial and/or non-financial competing interest among the authors of this paper.

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