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AMINO ACID AND FATTY ACID COMPOSITION OF ETHIOPIAN TARO

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Abstract

The purpose of this study was designed to investigate the amino acid and fatty acid composition of taro leaf and corm samples. An UHPLC and GC-FID method was used for the determination of amino acids and fatty acid composition, respectively. Taro leaf was processed as a powder and pre-curd concentrates while the corm was pre-gelatinized with and without peel prior to the analysis. The amino acid and fatty acid composition (%) of the analyzed samples were quantified with their relative area comparing with respective standards**.** In the present study, the leaf and corm of taro contained the three essential amino acids leucine, lysine and methionine. For the study, the calculated amino acid values were low in corm samples, but amino acid composition was higher in the leaf samples. Concerning fatty acids, the dominant fatty acid in the leaf and corm was oleic acid (C18:1, n-9) which ranged from 140.697 ± 0.054 to 216.775 ± 0.043 and 101.932 ± 0.023 to 101.950 ± 0. 04 mg/100 g, respectively. In the study, the fatty acid compositions in leaf were higher than the corm. This means that taro leaf would be considered as a good source of essential amino acid and fatty acid than the corm. Finally, from the proportion (mg/100 g) of saturated, monounsaturated and polyunsaturated fatty acids, the unsaturated fatty acids were the predominant fatty acids observed. The presence of high levels of unsaturated fatty acids in the entire investigation of our study taro is nutritionally rich.

Keywords: *Amino acid composition, Fatty acid composition, Taro Leaf, taro corm.*

1.0 BACKGROUND OF THE STUDY

The main nutritional value of roots and tubers lies in their potential ability to provide one of the cheapest sources of dietary energy, in the form of carbohydrates (Carpenter, *et al.*, 2001). Among the root crops, taro is one which provides a great amount (87 % of carbohydrates, fiber and minerals in developing countries like in Asia and Western Africa. However, the corm is claimed to be deficient in protein, fat and most vitamins, but contains a significant amount of dietary fiber and minerals (Behera, *et al*., 2009). In Ethiopia, taro is underutilized root crop and found commonly in south and south west Ethiopia (Adane *et al*., 2013). People are eating taro corm as boiled, but there is no awareness about the quality the leaf has. Leaf of taro is cooked and eaten as a vegetable in Asia and often in tropical Africa (Akwee, 2015).

The leaf contains high beta-carotene (135µg), iron (1.35 mg) and folic acid (3.28 mg) (Oueme, and Winston, 1999). The protein content in taro leaf is high (21 % DM) and rich with most of limiting amino acids than in many other tropical root crops, cereals and legumes (Ajijola, *et al*., 2003). At present, the nutritional and health values are the main concern when a crop is being considered as a food source. 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 root crops like taro (Hang and Preston, 2009). The analysis of taro leaf nutritional and anti-nutritional composition is an essential part of nutrition studies and important to know the overall nutritional qualities. It is a fact that there are some anti-nutritional factors and should be eliminated through thermal processing methods (Arinathan *et al.*, 2009). From this study both taro leaf and corm grown in Ethiopia were further analyzed for amino acid and fatty acid compositions in addition to their proximate, mineral and anti-nutritional constituents. The present study, therefore aimed at analyzing the amino acid and fatty acid profiles of taro grown in Ethiopia and further determined its nutritive value.

2.0 MATERIALS AND METHODS

2.1 Sample Source and Laboratory Analysis

Both fresh taro leaf and corm were brought from Areka Research Centre. Taro leaf was processed as a powder and pre-curd concentrates while the corm was pre-gelatinized with and without peel prior to the analysis. Finally, both the leaf and corm 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. The amino acid and fatty acid composition of the analyzed samples were quantified with their relative area comparing with the respective standards.

2.2. Amino acid Analysis Protocol

Samples of the leaf and corm were digested in acid and alkaline medium to the complete hydrolysis of the protein fraction. Briefly, 100 mg, of each sample, taro leaf and corm were digested with 3 ml of 6 N HCl at 200^0C 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 100^0C water bath for removing the chlorine gas. Hydrolyzed protein was completely dry with nitrogen gas and re-constituted with 200µl (0.2 ml) of 0.1 N HCl. For Trypthopan, alkaline hydrolysis was used and 50 mg, of each sample, taro leaf and corm were suspended in 20 ml of 3N-NaOH and sealed under N_2 gas and hydrolyzed for 3 hours at 110 ^{0}C heating oven. Following hydrolysis, centrifuged for 10 min at 4,000 RPM and then the supernatant was taken and diluted with 50 folds' water (milliq). Then, the final acid and alkaline hydrolysates 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.

2.2.1 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 Na_2HPO_4, $Na_2B_4O_7$ 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 min (1% B), 7.4 min (40% B), 10 min (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 min (Carl, 2015). In order to quantify amino acids, the mix standard was used from Asparagine, Alanine, Arginine, Aspartic acid, Cysteine, Glutamic acid, Glutamine, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Serine, Tyrosine, Valine, Proline, Tryptophan, Cysteine, Norleucine and Hydroxylproline 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. The amino acid composition in (%) of the analyzed pre-gelatinized taro corm samples were quantified with their relative area comparing with amino acid standard and the concentration of each amino acid in (g/100 g) was also calculated by multiplying the percentage of each amino acid with their percentage CP content. There were 9 essential amino acids and 12 non-essential amino acids detected in the analysis.

2.3 Fatty acid Analysis Protocol

Lipids from taro leaf and corm samples were extracted with hexane-isopropanol (3:2 v/v) with a modified method adapted from a previous study (Jana, *et al.*, 2004). Approximately 1 g 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 ^{O}C, for 5 minutes, after which the upper phase was removed to pre-weighed evaporation tubes using glass Pasteur pipettes. One milliliter 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 reweighed 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^{O}C.

2.3.1Methylation:

The concentration of lipids dissolved in hexane was calculated before methylation, by micro balance weighing (Metller type UMT2, Switzerland). The methylation of fatty acids was done using a modified method (Jana, 2014). 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 the 60 ^{O}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 ^{O}C for 20 minutes. The upper phase was transferred to a small glass vial

with pasteur pipettes and again stored at the 4 ^{O}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 the 40 ^{O}C with N_2 gas until dried (approx 20 minutes). Finally, 300 µL aliquots of lipids were transferred into test tubes and kept at the -18 ^{O}C until GC analysis.

2.3.2 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.

2.3.3 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 ^{O}C for 5 minutes and increased by 2 ^{O}C / minute up to 220 ^{O}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 ^{O}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). There were 22 fatty acids detected in the analysis, including, even number and odd number fatty acids.

2.3. Statistical Analysis

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

3.0 RESULTS AND DISCUSSION

3.1 Amino acid Composition in (g/100g)

As summarized in Table 1, the amino acid composition (g/100g) of the analyzed taro leaf powder and curd 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 (CP) content. There were 9 essential amino acids and 12 non-essential amino acids detected in the analysis at different concentration.

Table 1: Amino acids composition (g/100g) of taro leaf powder and curd samples from two varieties

Type of Amino acids		Treatments			
	Abbreviations	**BLP**	**BLC**	**LLP**	**LLC**
Essential amino acids (EAA)					
L-Histidine	His	2.4±0.30ab	3.54±0.31a	2.76±0.32ab	2.98±0.33ab
L- Threonine	Thr	4.9±0.31c	6.19±0.32a	5.78±0.33ab	5.87±0.34ab
L- Valine	Val	6.32±0.50a	6.67±0.51a	5.65±0.52ab	5.98±0.52ab
L- Methionine +Cys	M-Cy	4.08±0.25c	6.98±0.26a	5.65±0.27ab	5.87±0.27ab
L- Tryptophan	Try	3.36±0.26a	3.36±0.27a	2.65±0.28ab	2.98±0.29ab
L- Phenylalanine	Phe	6.32±0.50ab	7.65±0.51a	5.76±0.52ab	5.87±0.53ab
L- Isoleucine	Iso	3.99±0.11ab	4.54±0.12a	2.53±0.13b	3.51±0.14ab
L- Leucine	Leu	9.51±0.30a	9.78±0.31a	6.54±0.32b	7.56±0.33ab
L- Lysine	Lys	6.09±0.33ab	7.64±0.34a	4.54±0.35b	6.54±0.36ab
Non-essential amino acids (NEAA)					
L-Aspartic acid	Asp	9.97±0.04ab	11.97±0.05a	8.45±0.06b	10.87±0.07a
L-Glutamic acid,	Glu	11.66±0.42	11.98±0.43a	8.65±0.44	9.98±0.45
L-Asparagines	Asp	7.66±0.43	7.73±0.44	5.67±0.45	5.86±0.46
L-Serine	Ser	4.90±0.14	6.75±0.15	3.87±0.16	3.87±0.17
L-Glutamine	Glu	7.36±0.15	6.92±0.16	2.86±0.17	2.9±0.18
L-Glycine	Gly	5.01±0.07	7.65±0.08	4.65±0.09	5.87±0.10
L-Alanine	Ala	2.35±0.13	2.75±0.14	2.65±0.15	2.87±0.16
L-Arginine	Arg	5.91±0.67	6.61±0.68	4.55±0.69	5.79±0.70
L-Tyrosine	Tyro	4.34±0.11	5.78±0.12	3.67±0.13	3.78±0.14
L- Norleucine	Norl	3.8±0.18	3.78±0.19	1.54±0.20	1.98±0.21
L-Hydroxyproline	Hyd	2.34±0.13	2.65±0.14	2.45±0.15	2.98±0.16
L- prolyne	Pro	2.61±0.50	2.76±0.51	2.55±0.52	2.76±0.53

[c] *Means ± SD within a raw with similar superscripts did not differ significantly (p>0.05); SD: standard deviation; *: alkaline hydrolysed; AAs: Amino acids; BLP: Boloso-1 taro leaf powder; BLC: Boloso-1 taro leaf curd; LLP: Local taro leaf powder and LLC: Local taro leaf curd.*

The essential amino acids are ranging from His (3.54- 2.40), Thr (6.19- 4.90), Val (6.67-5.65), Met-Cys (6.98-4.08), Try (3.36-2.65), Phe (7.65-5.76), Iso (4.54-2.53), Leu (9.78-6.54), and Lys (7.64-4.54). Similarly, the non-essential amino acids are ranging for Asp (11.97-8.45), Glu (11.98-8.65), Asp (7.73-5.67), Ser (6.75-3.87), Glu (7.36-2.86), Gly (7.65-4.65), Ala (2.87-2.35), Arg (6.61-4.55), Tyr (5.78-3.67), Nor (3.8-1.54), Hyd (2.98-2.34) and Pro (2.76-2.55). The glutamic acid, aspartic acid and asparagine are the three dominant non-essential amino acids. The amino acid profile of the leaf samples showed a favorable balance of both essential and non-essential

amino acids to support the nutrient requirement of human and animal if mutually mixed with other foods.

From the result, shown in Table 1, boloso-1 taro leaf curd is relatively rich in leucine (9.78), valine (6.67), phenylalanine (7.65), lysine (7.64) and also adequate in threonine (6.19), tryptophan (3.36), methionone (6.98) and iso-leucine (4.54) amino acids of all. The second-high essential amino acid compositions were found in local taro leaf curd followed by boloso-1 taro leaf powder.

From variety point of view, boloso-1 taro leaf was found to be high in both essential and non-essential amino acid than its counter variety. From processing effect point of view, curd samples had a better amino acid composition than powder samples in both taro leaf varieties.

Table 2: Amino acids composition (g/100g) of pre-gelatinized taro corm samples from two varieties

Types of AAs	Abbreviations	Treatments			
		BPGF$_1$	BPGF$_2$	LPGF$_1$	LPGF$_2$
Essential amino acids(EAA)					
L-Histidine	His	1.4±0.22^{a}	1.41±0.31^{a}	1.37±0.4^{a}	1.45±0.21^{a}
L-Threonine	Thr	1.12±0.31^{a}	1.11±0.32^{a}	1.17±0.33^{a}	1.34±0.3^{a}
L-Valine	Val	1.32±0.32^{a}	1.02±0.5^{a}	1.31±0.43^{a}	1.54±0.35^{a}
L-Methionine + Cys	Met-Cys	1.21±0.5	1.01±0.34	1.14±0.24	1.45±0.32
L-Tryptophan *	Try	1.32±0.32	1.31±0.32	1.21±0.36	1.66±0.32
L-Phenylalanine	Phe	1.13±0.4	1.13±0.32	1.13±0.43	1.61±0.38
L-Isoleucine	Iso	1.32±0.43	1.12±0.43	1.02±0.3	1.01±0.23
L-Leucine	Leu	1.99±0.3	1.90±0.32	1.75±0.39	1.76±0.43
L-Lysine	Lys	1.86±0.32	1.47±0.4	1.59±0.1	1.54±0.41
Total EAA		12.67	11.48	11.69	13.36
Non-essential amino acids (NEAA)					
L-Aspartic acid	Asp	4.12±0.43	4.13±0.43	2.13±0.09	2.12±0.10
L-Glutamic acid,	Glu	2.12±0.53	2.03±0.43	1.54±0.47	1.430.48
L-Asparagines	Asp	1.45±0.3	1.04±0.12	1.05±0.48	1.33±0.49
L-Serine	Ser	1.33±0.43	1.03±0.18	1.06±0.19	1.23±0.20
L-Glutamine	Glu	1.43±0.4	1.04±0.43	1.03±0.20	1.31±0.21
L-Glycine	Gly	4.22±0.34	4.04±0.11	3.54±0.12	3.24±0.13
L-Alanine	Ala	1.33±0.21	1.05±0.17	1.11±0.18	1.32±0.19
L-Arginine	Arg	3.33±0.43	3.07±0.71	3.32±0.72	3.32±0.73
L-Tyrosine	Tyro	1.44±0.3	1.16±0.15	1.32±0.16	1.32±0.17
L-Norleucine	Nor	0.32±0.34	0.39±0.22	0.56±0.23	0.43±0.24
L-Hydroxyproline	Hyd	1.33±0.43	1.04±0.17	1.2±0.18	1.17±0.19
L-Prolynme	Pro	0.32±0.53	0.03±0.54	0.13±0.55	0.05±0.56
Total NEAA		22.74	20.05	17.99	18.24

*$^{a-ab}$ Means ± SD within a raw with similar superscripts did not differ significantly ($p>0.05$); SD: standard deviation; *: alkaline hydrolysed; AAs: Amino acids; BPGF$_1$: Boloso-1 taro pre-gelatinized flour with peel; BPGF$_2$: Boloso-1 taro pre-gelatinized flour without peel; LPGF$_1$: local taro pre-gelatinized flour with peel; LPGF$_2$: local taro pre-gelatinized flour without peel*

From this study, it can be deduced that the amino acid composition is affected by both taro leaf varieties and processing methods, there is limited research results on processed taro leaf amino acid composition and the findings of this study was reviewed with other amino acid composition of yam, cassava and Moringa leaves. As noted by different researchers (Sheela *et al*., 2004; Ayodele and Olajide, 2011; Busani *et al*., 2011), the amino acid profile of the present study was potentially enough than yam and cassava leaf. For the present study, the amino acid profiles, suggesting that high values were obtained from taro leaf curd concentrate and had adequate sulphur containing amino acid. Therefore, the findings of this study were found to be curd processing had a very significant increase of amino acid composition and agreement with the work of Aletor and Fasuyi (1997) who reported an increased amino acid composition of cassava leaf concentrate due processing.

The essential amino acids in pre-gelatinized corm is ranging His (1.45-1.37), Thr (1.34-1.11), Val (1.54-1.02), Met-Cys (1.45-1.01), Try (1.66-1.21), Phe (1.61-1.13), Iso (1.32-1.01), Leu (1.99-1.75) and Lys (1.86-1.47). The leucine, lysine and tryptophan are the three highest essential amino acid found in the present study, respectively. Similarly, the non-essential amino acids are ranging for Asp (4.12-2.12), Glu (2.12-1.43), Asp (1.45-1.04), Ser (1.33-1.03), Glu (1.43-1.03), Gly (4.22-3.24), Ala (1.33-1.05), Arg (3.33-3.07), Tyr (1.44-1.16), Nor (0.56-0.32), Hyd (1.33-1.04) and Pro (0.32-0.03). The aspartic acid, glycine and arginine are the three dominant non-essential amino acids, respectively. The calculated values are close, but the essential amino acid composition was slightly higher in local taro pre-gelatinized flour with peel and the second-high essential amino acid compositions were found in boloso-1 taro pre-gelatinized flour without the peel. Further, boloso-1 taro pre-gelatinized flour was found to be higher in non-essential amino acid than its counter variety. Thus, through this study amino acid composition was affected mainly by taro varieties and pre-gelatinized methods did not influence the amino acid composition.

3.2. Fatty acid Composition and Proportion (g/100g)

Table 3 Fatty Acid Composition

Class of FAs	Treatments			
	BLP	BLC	LLP	LLC
$C_{14:0}$	2.512±0.01^{a}	2.346±0.03^{ab}	2.069±0.01^{ab}	1.278±0.03^{c}
$C_{14:1}$	0.319±0.02^{a}	0.129±0.05^{ab}	0.058±0.04^{ab}	0.126±0.03^{ab}
$C_{15:0}$	0.319±0.01^{a}	0.129±0.06^{ab}	0.058±0.03^{ab}	0.126±0.03^{ab}
$C_{16:0}$	210.684±0.02^{ab}	212.806±0.06^{a}	192.921±0.05^{c}	96.465±0.04^{d}
$C_{16:1(n-7)}$	15.302±0.02^{a}	15.277±0.01^{b}	13.795±0.05^{c}	1.266±0.05^{d}
$C_{17:0}$	0.319±0.01^{ab}	0.129±0.04^{ab}	0.058±0.06^{b}	0.389±0.05^{a}
$C_{17:1}$	3.472±0.02^{a}	3.317±0.04^{ab}	2.95±0.05^{b}	0.49±0.01^{c}

$C_{18:0}$	105.919±0.05^{a}	106.89±0.05^{a}	96.873±0.06^{b}	35.72±0.04^{c}
$C_{18:1(n-9)}$	214.61±0.01^{ab}	216.775±0.04^{a}	196.52 ±0.05^{c}	140.697±0.05^{d}
$C_{18:2(n-6)}$	55.18±0.01^{b}	55.593 ± .05^{b}	50.35 ± .06^{c}	334.069±0.01^{a}
$C_{18:3(n-3)}$	0.319±0.02^{b}	0.129±0.03^{b}	0.058±0.06^{bc}	16.079±0.02^{a}
$C_{20:0}$	0.319±0.02^{b}	0.129±0.04^{b}	0.058±0.06^{bc}	3.249±0.04^{a}
$C_{20:1(n-9)}$	0.319±0.02^{b}	0.129±0.03^{b}	0.058±0.06^{bc}	1.366±0.03^{a}
$C_{20:2(n-6)}$	0.319±0.03^{a}	0.129±0.04^{ab}	0.058±0.08^{ab}	0.126±0.03^{ab}
$C_{20:3(n-6)}$	0.319±0.02^{a}	0.129±0.04^{ab}	0.058±0.03^{ab}	0.126±0.05^{ab}
$C_{20:4(n-6)}$	26.337±0.03^{a}	26.433±0.06^{a}	23.912±0.02^{b}	0.126±0.04^{c}
$C_{20:3(n-3)}$	0.319±0.03^{a}	0.129±0.06^{ab}	0.058±0.02^{b}	0.126±0.01^{ab}
$C_{22:0}$	0.319±0.03^{b}	0.129±0.06^{b}	0.058±0.03^{b}	2.449±0.02^{a}
$C_{22:1(n-9)}$	0.319±0.01^{a}	0.129±0.02^{ab}	0.058±0.03^{b}	0.126±0.05^{ab}
$C_{24:0}$	0.319±0.02^{a}	0.129±0.04^{ab}	0.058±0.04^{b}	0.126±0.05^{ab}
$C_{24:1(n-9)}$	0.319±0.02^{a}	0.129±0.05^{ab}	0.058±0.03^{ab}	0.126±0.05^{ab}
$C_{22:6(n-3)}$	5.85±0.02^{a}	5.721±0.03^{a}	5.13±0.04^{ab}	0.126±0.05^{c}
Total FAs	644.013±0.05	646.835±0.05	585.28±0.06	634.777±0.05
Proportion (g/100 g), SFA, MUFA, PUFA and UFA: SFA				
SFAs	320.71 ±.123	322.687±.123	292.15±.43	139.80±.54
MUFAs	234.66±.34	235.885±.432	213.49±.42	144.19±.64
PUFAs	88.324±.456	88.134±.534	79.57±.53	350.65±.76
UFAS	322.984±.546	324.019±.432	293.06±.54	494.84±.34
UFA: SFA	1.007091±.012	1.004128±.021	1.00±.03	3.532±.04

$^{a-d}$ Means ± SD within a raw with similar superscripts did not differ significantly (p>0.05); SD: standard deviation; FAs: Fatty acids; SFAs: Saturated Fatty acids; MUFAs: Mono-unsaturated Fatty acids; PUFAs: Poly-unsaturated Fatty acids; UFAs: Unsaturated Fatty acids; BLP: Boloso-1 taro leaf powder; BLC: Boloso-1 taro leaf curd; LLP: Local taro leaf powder and LLC: Local taro leaf curd.

The fatty acid composition in mg/100 g (Table 3) of the analyzed taro leaf powder and curd samples was identified with their retention time and quantified with relative area comparing with the fatty acid standard. In the present study, there were 22 fatty acids detected, including the 19 even number fatty acids from C_{14} – C_{24} and three odd number fatty acids of C_{15} and C_{17} in different concentration. The occurrence of trans fatty acids in taro has not been detected and it is not expected (Kalac, 2009). The overall fatty acid differences in boloso-1 taro leaf powder and curd extract were not significant ($P>0.05$). However, there were significant ($P<0.05$) differences in local taro leaf powder and curd extract. The dominant fatty acid is oleic acid ($C_{18:1, n-9}$) ranging from (216.775± 0.043 -140.697± 0.054) mg/100 g. The next three dominant fatty acids are palmitic acid ($C_{16:0}$), oleic acid ($C_{18:0}$) and linoleic acid ($C_{18:2, n-6}$) ranging from (210.684 ± 0.02- 96.465± 0.043, 106.89 ± 0.054- 35.72 ± 0.043 and 334.069 ± 0.01-50.355 ± 0.056) mg/100 g values, respectively. The essential fatty acids $C_{18:2}$ and $C_{18:3}$ are found in low concentration as compared to oleic acid. From taro leaf samples Boloso-1 taro leaf curd had relatively high levels of fatty acid fractions and low levels of fatty acid fractions were obtained in local taro leaf powder (Table 3). This might be due to variety differences and the effect of pre-treatments prior to analysis. Valasco *et al.* (2008) concluded that differences in fatty acid concentrations have been found between taro cultivars even harvested at the same stage of development. Again, similar findings have been made that the predominant fatty acids in the leaf of root crops were oleic, linoleic, palmitic and linolenic acids orderly (Katiyar *et al*., 2005).

From the proportion (mg/100 g) of saturated, monounsaturated and polyunsaturated fatty acids, unsaturated fatty acids are the predominant fatty acids in leaf curd (Table 3). This is further verified by calculating the ratio of unsaturated: saturated fatty acids, which all are greater than one. This is consistent with the observation that, in taro and other root crops, unsaturated fatty acids predominate over the saturated, in the total fatty acid content (Alozie *et al.,* 2010; Bhandari *et al*., 2003; Brown *et al*., 2008).

Table 4 summarizes the fatty acid composition in mg/100 g of the analyzed pre-gelatinized taro corm flour samples. Taro corms pre-gelatinized without peel were analyzed for fatty acid. Fatty acids were identified with their peak retention time and quantified with relative area computing. There were 22 fatty acids detected in the analysis, including, 19 even number fatty acids from C_{14} – C_{24} and two odd number fatty acids of C_{15} and C_{17} in different concentration. The occurrence of trans fatty acids in taro has not been reported and it is not expected (Kalac, 2009). The overall fatty acid differences in boloso-1 and local taro is not significant.

Table 4: Fatty acid profile (mg/100 g) of pre-gelatinized taro corm samples

Class of FAs	Treatments		FAs		
	BPGF	LPGF		BPGF	LPGF
$C_{14:0}$	1.462±0.023[a]	1.444±. 043[a]	$C_{20:0}$	0.423±0.012[a]	0.405±0.012[a]
$C_{14:1}$	0.423±0.043[a]	0.405±. 012[a]	$C_{20:1(n-9)}$	0.423±0.023[a]	0.405±0.012[a]
$C_{15:0}$	0.423±0.03[a]	0.405±0.02[a]	$C_{20:2(n-6)}$	0.423±0.032[a]	0.405±. 02[a]
$C_{16:0}$	100.090±. 03[a]	100.072±.023[a]	$C_{20:3(n-6)}$	0.423±0.012[a]	0.405±0.012[a]
$C_{16:1(n-7)}$	7.522±. 043[a]	7.504±0.032[a]	$C_{20:4(n-6)}$	12.750±0.013[a]	12.732±. 021[a]
$C_{17:0}$	0.423±0.021[a]	0.405±0.023[a]	$C_{20:3(n-3)}$	0.423±0.032[a]	0.405±0.012[a]
$C_{17:1}$	1.917±0.021[a]	1.899±0.012[ab]	$C_{22:0}$	0.423±0.023[a]	0.405±0.023[a]
$C_{18:0}$	50.454±. 021[a]	50.436±0.02[a]	$C_{22:1(n-9)}$	0.423±0.01[a]	0.405±0.03[a]
$C_{18:1(n-9)}$	101.950±. 04[a]	101.932±. 023[a]	$C_{24:0}$	0.423±0.012[a]	0.405±0.03[a]
$C_{18:2(n-6)}$	26.415±0.043[a]	26.397±0.023[a]	$C_{24:1(n-9)}$	0.423±0.012[a]	0.405±0.023[a]
$C_{18:3(n-3)}$	0.423±0.05a	0.405±0.0123[a]	$C_{22:6(n-3)}$	3.043±. 021[a]	3.025±0.021[a]
Proportion (mg/100 g), SFA, MUFA, PUFA and UFA: SFA					
SFA	154.12±.054	153.98±.065	UFA	156.56±.064	156.32±.067
MUFA	113.08±.054	112.96±.065	UFA: SFA	1.015832±.021	1.015197±.012
PUFA	43.48±.032	43.37±.032	Total FA	310.68	310.3

[a-ab] Means ± SD within a raw with same superscripts did not differ significantly (p>0.05); SD: standard deviation; FAs: Fatty acids; SFAs: Saturated Fatty acids; MUFAs: Mono-unsaturated Fatty acids; PUFAs: Poly-unsaturated Fatty acids; UFAs: Unsaturated Fatty acids; BPGF: Boloso-1 taro pre-gelatinized flour without peel LPGF: local taro pre-gelatinized flour without peel.

The dominant fatty acid is oleic acid ($C_{18:1, n-9}$) ranging from (101.950 ± 0. 04 - 101.932 ± 0.023) mg/100 g. The next three dominant fatty acids are palmitic acid ($C_{16:0}$), oleic acid ($C_{18:0}$) and linoleic acid ($C_{18:2, n-6}$) ranging from (100.090 ± 0.03 - 100.072 ± 0.023), (50.454 ± 0. 021-50.436 ± 0.02) and (26.415 ± 0.043 -26.397 ± 0.023) mg/100 g values respectively. Similar findings have been found that the predominant fatty acids in root crops like taro and yam were oleic, linoleic, palmitic and linolenic acids orderly (Islam *et al*, 2012 ; Katiyar *et al*., 2005). From taro pre-gelatinized corm flour, boloso-1 taro has relatively high levels of fatty acid fractions and low levels are obtained in local taro pre-gelatinized flour (Table 4). This might be due to variety differences. However, taro pre-gelatinization had no effect on fatty acid composition. Valasco *et al.* (2008) concluded that differences in FA concentrations have been found between taro cultivars even harvested at the same stage of development.

From the proportion (mg/100 g) of saturated, monounsaturated and polyunsaturated fatty acids, unsaturated fatty acids in corm flour are slightly higher than saturated ones (Table 2). This is further verified by calculating the ratio of unsaturated: saturated fatty acids, which all are greater

than one. In taro and other root crop, unsaturated fatty acids predominate over the saturated, in the total fatty acid content (Alozie *et al.*, 2010; Bhandari *et al.*, 2003; Brown *et al*., 2008). Although, the overall amount of crude fat in the corm is very low (3.421±0.659), the fatty acid profile of the tuber was very good, considering that linoleic acid (an essential fatty acid) was found in high level. This means that this tuber would not be considered a good source of essential fatty acid, but it is a very good source of carbohydrate (just like most root crops).

4.0 CONCLUSIONS

To conclude the amino acid and fatty acid composition of taro leaf and corm from this study, both amino acid and fatty acid compositions were affected mainly by taro varieties. For the leaf, boloso-1 taro leaf had relatively high levels of amino acid and fatty acid fractions while low levels of fractions were obtained in local taro leaf. For the corm, the overall composition of amino acid and fatty acid in taro corm were very lower than taro leaf. This means that taro leaf would be considered a good source of essential amino and fatty acid, but the corm is still a very good source of carbohydrate just like most root crops.

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