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Physicochemical and Functional Properties of Six Varieties of Taro (*Colocasia esculenta* L. Schott) Flour

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Abstract: Taro corms/cormels of six taro varieties [Country Ekona, Ibo Ekona, Country Ngdere, Ibo Ngdere, Kwanfre Ngdere and Sosso Chad] were converted into flour and analysed for some physicochemical and functional properties. In general a wide variation was observed in the chemical compositions of the flour samples analysed. On a dry weight basis, crude proteins ranges between 2.7 and 5.4%; available carbohydrate 33.3-77.8%; crude fibre 0.3-3.8%; ash 3.5-5.7% and crude starch 41.2-64.4%. No significant difference was observed in the amino acid composition and in all cases the most abundant amino acids were aspartic acid (16%); glutamic acid (12%) and leucine (10%). Similarly, wide variations were observed in their functional properties of the flour: water absorption capacity ranged from 242 to 375%; bulk density 0.57 to 0.71g mL^{-1}, oil absorption capacity 242 to 374%, water solubility index 18-to 28%; foam capacity 9 to 14%, blue value index 6 to 28eq DO/100 g flour, pH 6 to 7 and titratable acidity from 0.6 to 1.0 g eq.oxalic acid/100 g flour. Significant correlations were observed between such consitutents and functional properties as Amylose and blue value index; amylose and water solubility index; available carbohydrate and foam capacity; bulk density and starch.

Key words: Taro, flour, varieties, chemical composition, functional properties

INTRODUCTION

Taro (*Colocasia* sp.) is a food crop widely cultivated in tropical areas of the world[1,2]. In Cameroon, it is commonly used in the preparation of a much cherished and widely consumed food, known as *Achu* obtained by pounding cooked taro corms and or cormels in a mortar to obtain a smooth paste. Unfortunately however, the method of preparation is generally is not only laborious, but equally time consuming and as such not very convenient for individuals living in a busy urban setting. In addition to this, the acridity[3] of the corms and cormels, the high rate of post harvest loss and the lack of proper scientific attention to this problem, in Cameroon, has contributed to a more than 70% drop in annual production rate[4,5]. This observation prompted a project aimed at developing taro flour that could be used in the preparation of achu[6].

The use of a flour in food processing depends largely on its functional properties, which in turn depends on its chemical composition[7]. Data on the physicochemical and functional properties of taro flour in general are very limited. As of now, the only studies conducted on the functional properties of taro flour are those by Tagodoe and Hong[2,8] on Hawaiian samples. In Cameroon, studies on the composition of taro are limited to those carried out by Agbor Egbe[9].

The objective of this study was to assess the chemical composition and functional properties of flours obtained from six varieties of taro commonly grown and consumed in Cameroon and Chad.

MATERIALS AND METHODS

Taro samples and treatments: Taro corms and cormels of 6 varieties were obtained from radomly selected peasant farms in Cameroon and Chad. In Cameroon, three varieties (Country Ngdere, Ibo Ngdere and Kwanfre Ngdere) were harvested from a farm in Ngaoundere; two varieties (Country Ekona and Ibo Ekona) from a farm in Ekon. In Chad, the variety, Sosso Chad, was harvested from a farm in Mayo Kebbi. The Cameroonian varieties were harvested at a maturity age of 8-9 months after planting while that from Chad was at 7 months after planting. After harvesting, the corms and cormels were immediately taken to the laboratory where they were washed, cleaned and rinsed with copious amounts of clean water and and allowed to drip dry. The cleaned corms and cormels were

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weighed, hand peeled using a stainless steel knife reweighed and then cut into 0.5cm-thick slices, which were then spread on perforated aluminium trays and placed inside a convection oven and dried for 48 h at 45±2°C. The dried slices were then fine milled (500 μm) using an electrical powered Cullati grinder (Polymix, Kinematica AG, Luzernerstrasse, Germany). Flours obtained were packaged in polyethylene bags and stored in a desiccator until required for subsequent analysis.

Tuber size, crude starch and apparent amylose content of taro flour: 25 individual corms of each variety were evaluated for their ratio of the weight of peeled to that of unpeeled. Crude starch was determined by the modified method of Jane[1]. In this method, flours were hydrated in a 0.2M KOH solution 1:10 (w/v) for 1hr and blended for 30 min using a Warring blender after which the mixture was sieved through 150 μm mesh and the filtrate allowed to settle over night. The residue was recuperated and washed twice with distilled water. After the third washing, the residue was then dried at 45±2°C for 48 hrs. The dried starch was weighed and the yield expressed as a percentage of the initial weight of the flour used for the extraction.

The amylose content of the extracted starch was evaluated according to the procedure of Chrashi[10]. Following this method, the starch was methanol extracted, solubilised in alkaline solution and analysed for amylose content.

Proximate analysis: Flours samples were analysed in triplicate for crude fibre, total fat, ash and moisture contents using the standard methods of the Association of Official Analytical Chemists[11]. While crude protein content was evaluated by acid digestion of flour subsamples in Kjeldhal tubes followed by the spectrophotometric method of Devani[12]. Available carbohydrate was determined after digestion in sulphuric acid followed by analysis of reducing sugars using the 3, 5-dinitrosalicylic acid (DNS) method as previously described[13].

Amino acid analysis: Two varieties (WSC and WCN) of taro flour were used for amino acid analysis. The amino acid profile of acid digest taro flour was determined in duplicates by reverse phase high performance liquid chromatography (HPLC) as described by Mbofung[14]. The instrument was a Perkin Elmer HPLC system consisting of an LC200 series pump, a Rheodyne injection valve with a 20 μL sample loop, a Waters column in a column heater, an Applied Biosystems UV absorbance detector and a 1022 data handling computer. All the reagents used were HPLC grade. Tryptophan levels were not determined.

Free sugars: Free sugars in taro were extracted into alcohol, concentrated by lyophilisation and rehydration in water and run on a TLC (thin layer chromatography) plate coated with a silica gel 60 F_{254}.

***In vitro* carbohydrate digestibility:** *In vitro* carbohydrate digestibility was determined on 1h boiled taro flour after hydrolysis of taro flour by salivary amylase in dialysis bag using the method described by Dahlin[15]. The *In vitro* carbohydrate digestibility was expressed as total reducing sugars in g/100g, on a dry wet basis.

Functional properties: The apparent Water Absorption Capacity (WAC), Water Solubility Index (WSI° and Blue Value Index (BVI) were evaluated respectively according to the methods of Philiips, Anderson and Njintang[16-18]. Emulsifying activity (Ea) and Emulsion stability (Es) were evaluated essentially according to the method of Yatsumatsu[19] while Foam Capacity (Fc) was determined according to the method of Coffman[20] and Bulk Density (Bd) of taro flour was determined according to the method of AOAC[11]. Titratable Acidity (Ta) and pH were evaluated in water extracted from taro flour (50g flour 100 mL water) following the ANFOR[21] procedures.

Statistical analysis: All data obtained were subjected to analysis of variance and multiple comparison of Fischer and the correlations analysis using the *Stat Graphics* statistical package while graphic representations were made using the *Sigma Plot* graphics package.

RESULTS AND DISCUSSION

Taro size, starch and amylose: In general, the ratio of peeled to unpeeled taro corms did not vary significantly between varieties (Table 1). However, variety Kwanfre Ngdere exhibited the highest value (78.5%). Wide variations were observed in the starch levels of the different varieties studied (Table 2) with Kwanfre Ngdere variety having the lowest (51.9%) value while Sosso Chad had the highest (64.44%). The crude starch levels obtained in these experiments are similar to those reported for *Colocasia* (50.9-66.2%) and *Xanthosoma* (65.4-70.6%) by Agbor-Egbe[22]. According to Nip[3] such differences might be related to the maturity of the corms because starch tends to accumulate with maturity. In the present study only mature corms/cormels (7-10 months) were used. A wide variation was equally observed in the apparent amylose content of the different samples. Starch amylose levels ranged between 17 to 35% with Sosso Chad variety having the greatest contents while the Ibo Ekona variety had the least. On a comparative basis, most of the samples analysed fall within the range of values (18 to 24%) reported by Jane[1], for taro cultivars from Hawaii.

Table 1: Tuber size, starch and amylose content of flours from different taro varieties

	Varieties					
Parameters	Ibo Ekona	Ibo Ngdere	Country Ekona	Country Ngdere	Sosso Chad	KwanfreNgdere
Tuber size	65.72±4.12^{ab}	59.14±6.32^{b}	73.58±5.11^{ab}	59.32±3.25^{b}	66.99±7.14^{ab}	78.46±3.04^{a}
Starch (%)	47.78±2.53^{bc}	57.47±4.60^{ab}	56.14±4.11^{ab}	41.27±5.20^{c}	64.44±4.17^{a}	51.93±3.25^{abc}
Apparent amylose (%)	17.07±1.57^{c}	25.60±1.69^{b}	26.53±3.41^{b}	24.93±6.60^{b}	35.73±3.37^{a}	22.8±1.47^{b}

Means ±SD; n=3; Figs. in a row followed by different superscripts indicate significantly ($p<0.05$) different values determined by Duncan's Multiple Range Test

Table 2: Some chemical composition of flours from 6 taro varieties grown in Cameroon and Chad

	Varieties					
Characteristics	Country Ekona	Ibo Ekona	Country Ngdere	Ibo Ngdere	Kwanfre Ngdere	Sosso Chad
Moisture (%)*	81.55±6.43^{a}	67.81±1.24^{c}	76.43±0.52^{ab}	61.10±1.08^{c}	68.10±2.06^{bc}	64.63±5.08^{c}
Ash (%)	4.58±0.05^{b}	5.65±0.25^{a}	4.02±0.37^{cd}	4.09±0.10^{bc}	3.54±0.08^{d}	3.79±0.16^{cd}
Total fat (%)	0.59±0.25	0.53±0.21	0.34±0.08	0.73±0.17	0.37±0.24	0.48±0.09
Crude starch (%)	56.14±4.11^{ab}	47.78±2.53^{bc}	41.27±5.20^{c}	57.47±4.60^{ab}	51.93±3.25^{abc}	64.44±4.17^{a}
Amylose (%)	26.53±3.41^{b}	17.07±1.57^{c}	24.93±6.60^{b}	25.60±1.69^{b}	22.8±1.47^{b}	35.73±3.37^{a}
Crude Proteins (%)	4,33±0,23^{c}	2,66±0.13^{d}	4,45±0.14^{bc}	2,57±0.16^{d}	5,41±0,22^{ab}	5,00±0,10^{a}
Available Carbohydrates (%)	36.40±2.04^{cd}	41.89±0.11^{cd}	33.29±2.23^{d}	48.01±2.41^{bc}	56.31±2.01^{b}	77.83±5.02^{a}
Crude fibre (%)	0.74±0.05^{c}	0.35±0.02^{d}	0.36±0.03^{d}	0.75±0.05^{c}	1.16±0.08^{b}	3.78±0.27^{a}

Means ±SD; n=3; Figs. in a row followed by different superscripts indicate significantly ($p<0.05$) different values determined by Duncan's Multiple Range Test. *Expressed in the fresh weight basis

On average, the observed values are similar to that quoted for potato starch (about 20%) but lower than that of corn starch (28-30%)[23]. The extractable starch and the amylose contents of the white and red varieties cultivated in Ekona were comparatively different when compared to the same varieties cultivated in Ngaoundere. This observation suggests that the composition of taro is affected by the location of where it is cultivated. On the other hand a significant correlation (R=0.76, p=0.00) was observed between starch and amylose levels and thus inferring that high starch contaning varieties are equally high in amylose content. Since the retrogradation of starch is usually influenced by its amylose content[24] the high correlation between starch and amylose suggest the retrogradation pattern of the starch in the different varieties.

Proximate composition: Table 3 shows the proximate composition of taro varieties all expressed on a dry weight basis except for moisture content, which is expressed on a fresh weight basis. In general, freshly harvested samples were very high in moisture content with moisture content ranging from 61% for the Ibo Ngdere variety to 82% in the Country Ekona variety. Analysis of variance showed that these variations were significant ($p<0.05$) across the different varieties. The observation of high moisture content confirms the well-known characteristic feature of root and tubers crops. Indeed these values are comparable to those of *Colocasia* (70.4 to 86.5%) and *Xanthosoma* (51.4-71.6%) inferred from the results reported by Agbor-Egbe[22]. The crude proteins values also varied significantly ($p<0.05$) from 2.5% for the Ibo Ngdere variety to 5.4% in the Kwanfre Ngdere variety and

Table 3: Amino acid composition of taro flour from Ibo Ngdere and Sosso Chad varieties

Amino acid	Ibo Ngdere	Sosso chad
Essential amino acid		
Threonine	4.45	4.10
Isoleucine	4.04	4.19
Leucine	10.72	10.37
Lysine	5.43	5.55
Methionine + Cystein	0.12	0.10
Phenylalanine (Phe)	5.93	5.57
Tyrosine (Tyr)	1.46	1.05
Phe + Tyr	7.39	6.62
Valine	6.40	6.27
Histidine	2.22	2.52
Non essential amino acid		
Alanine	5.93	6.08
Aspartic acid	16.07	15.23
Glutamic	12.03	12.33
Glycine	6.18	6.08
Proline	4.78	4.73
Serine	6.07	5.76
Arginine	6.32	6.72
Other amino compounds		
Ethanolamine	0.00	0.35
Ornithine	0.11	0.17
Hserine	0.00	0.26
Gaba	1.61	2.40

Trypophane was not determined Means are expressed in g/100g, on dry weight basis

are comparable to those (1 to 4%) obtained by Bradbury[25]. Irrespective of the cultivars, taro flours were low in protein content. Studies by Martin[26] revealed that for some cultivars of taro grown in the mountainous areas of Puerto Rico, the protein content was generally quite high (11.7%). The total fat levels of taro flour were generally low and ranged between 0.3 to 0.6%. On the other hand all varieties were found to contain high levels of available carbohydrates and as such they are a good source of energy. Variation in the available carbohydrate

Table 4: Physicochemical properties of taro flour from 6 taro varieties grown in Cameroon and Chad

	Varieties					
Properties	Ibo Ekona	Ibo Ngdere	Country Ekona	Country Ngdere	Sosso Chad	Kwanfre Ngdere
Water absorption capacity	361.94±14.40^{a}	242.45±9.36^{c}	273.43±10.43^{c}	374.86±8.97^{a}	270.84±5.84^{c}	320.58±10.31^{b}
Oil absorption capacity (g/ 100 g)	174.37±0.73^{c}	186.53±0.42^{a}	185.80±2.70^{a}	180.08±0.65^{ab}	179.05±0.13^{bc}	186.52±0.65^{a}
Water solubility index (g/100g)	25.64±2.32^{ab}	27.64±2.97^{a}	19.80±3.67^{c}	20.25±1.97^{c}	22.25±2.06^{bc}	18.55±0.85^{c}
Foam Capacity (ml/100ml)	13.5±0.10^{a}	12.02±0.10^{b}	12.02±0.22^{b}	10.01±0.20^{c}	10.01±0.20^{c}	9.75±0.50^{c}
Emulsion activity (ml/ 100ml)	39.07±1.55	39.06±3.41	38.41±2.99	39.80±3.20	40.70±1.34	43.45±2.31
Emulsion stability (ml/ 100ml)	25.87±3.96^{b}	35.08±1.60^{a}	42.52±0.76^{a}	36.63±1.16^{a}	41.38±0.55^{a}	41.72±2.14^{a}
Blue value index (eq DO/ 100g)	14.77±0.56^{b}	28.37±0.33^{a}	6.74±1.89^{b}	6.39±1.02^{b}	9.38±1.13^{b}	5.69±071^{b}
Bulk density (g/ml)	0.71±0.01^{a}	0.59±0.01^{c}	0.57±0.01^{c}	0.68±0.01^{b}	0.59±0.01^{c}	0.69±0.01^{ab}
Titratable Acidity (g oxalic acid/100g)	0.99±0.08^{a}	0.69±0.01^{b}	0.94±0.10^{a}	0.74±0.01^{b}	0.68±0.05^{b}	0.76±0.05^{b}
pH	7.04±0.04^{a}	6.70±0.04^{b}	6.75±0.04^{b}	6.53±0.04^{c}	6.69±0.09^{b}	6.24±0.04^{d}

Means ±SD; n=3; Figs. in a row followed by different superscripts indicate significantly ($p<0.05$) different values determined by Duncan's Multiple Range Test

content of the different varieties was significant ($p<0.05$). In general, the Sosso Chad variety was found to have the highest available carbohydrate content while the white varieties, Country Ngdere and Country Ekona, had the lowest content.

The available carbohydrate is known as the part of carbohydrate that can be absorbed by the intestine into the blood stream. In fact, available carbohydrate is highly correlated to starch level (R=0.73; p=0.01) and consequently to its amylose content (R = 0.63; p = 0.03), to the fibre content (R = 0.93; p = 0.00). Crude fibre varied significantly from 0.4% (variety Ibo Ekona) to 3.8% (variety Sosso Chad). Crude fibre content was shown to be positively correlated to the available carbohydrate (R=0.93; p=0.00), amylose (R = 0.75; p = 0.01) and starch (R=0.70; p=0.00) contents of taro flour. The range of ash (3.5-5.7) obtained in this study falls within the one reported by Agbor-Egbe[22] on Cameroonian taro cultivars.

In general taro corms consisted mostly of water and starch. It also contains appreciable amounts of minerals as suggested by its ash content.

Amino acids: Table 4 presents the amino acid composition of Ibo Ngdere and Sosso Chad varieties, grouped into essential, nonessential and others. Compared to the[27] reference, the proteins in taro are very poor in sulphur containing amino acids (methionine and cysteine)[25,28,29] also made these observations. In general the total essential and non-essential amino acid levels did not vary significantly with variety. However, data given by FAO[30] suggests that taro contains more essentials amino acid than other currently consumed tubers. Amino acids with highest levels were aspartic acid, glutamic acid and arginine. These observations agree with those of Agbor-Egbe[22] who reported the chemical composition of 32 cultivars of *Colocasia esculenta* var. antiquorum and *Xanthosoma* sp.

Significant differences were observed in the ethylamine, Homoserine and γ amino barbituric acid (Gaba) content of the two varieties of taro analysed. In particular, the Ibo Ngdere variety contained relatively little or no ethylamine and Homoserine. This information may be of taxonomic importance in the description of these varieties. Studies by Ukoha[31] had shown that differences in the levels of amino compounds could be used to differentiate between varieties of plants.

Free sugars: When sprayed with the anilin-diphenylamine-H_3PO_4 reagent, one blue-violet band appeared on the plate from each sample, indicating the presence of free sugars. The band had a R_f value of 0.6 for the taro flour from each variety. The Rf values of standards maltotriose, maltose and glucose run on the same plate were 0.5, 0.6 and 0.7, respectively. This, therefore, suggests that the major sugar in the taro flour studied is a disaccharide. In an earlier study by Michiyoshi[32], sucrose, maltose, glucose and fructose had been identified as the major sugars in taro. These authors also observed that the glucose and fructose content of taro increased with age of tubers. For fresh and stored taro grown in Cameroon, Agbor-Egbe[22] reported that sucrose content represented about 69% of total sugar content. Similar analysis of taro from Bangladesh revealed much higher concentration (87%) of sucrose[29]. On the other hand analysis of Papua New Guinea taro cultivars showed much lower concentrations of 10, 10, 40 and 40% for sucrose, maltose, glucose and fructose, respectively[33].

***In vitro* carbohydrate digestibility:** Figure 1 shows the *In vitro* carbohydrate digestibility of the different taro varieties. Although taro starch is known to be relatively highly digestible[34], there was an initial lag time in the digestibility of the varieties. Differences observed in the carbohydrate digestibility of the varieties could be due to carbohydrate structures or interactions between carbohydrates and mucilage or dietary fibre of taro flour[35] observed a variation in the starch digestion rate

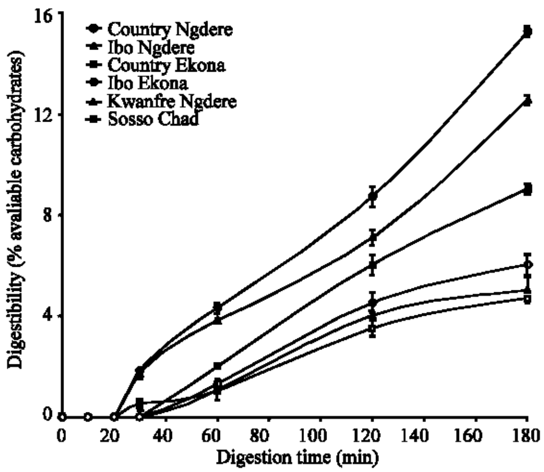

Fig. 1: *In vitro* carbohydrate digestibility of flour obtained from different taro varities

of three varieties of rice and related this to the difference in physicochemical properties of the starch. This could also be due partly to the high dietary fibre content of taro tubers.

Functional properties: The functional properties of the different taro flours are presented in Table 5. With the exception of emulsion capacity and stability, significant variations were observed in the levels of the different properties measured[36] working on different varieties of potatoes have also reported similar variations in some functional properties.

The ability to absorb water is a very important property of all flours used in food preparations. The range of water absorption capacity (242.5-374.9%) observed for the different flours analysed was systematically higher than that reported by Tagodoe[2] for raw and cooked taro flours. This systematic difference may partially be explained by differences in the methods used for the determination of water absorption capacity. In the study by Tagodoe[2] water retention and not water absorption was measured. Water retention is generally lower than water absorption. The ability of food materials to absorb water is sometimes attributed to its proteins content[37]. The observed water absorption capacity of flours studied cannot, however, be attributed to their protein content since taro is very poor in protein. In addition no linear correlation was observed between protein content and the water absorption capacity. However a significant correlation was observed with starch content (R=0.58; p =0.05).

The range of flour bulk density values (0.57-0.71g mL^{-1}) of the different flours was equally higher than that (0.43 to 0.49 g mL^{-1}) reported by Tagodoe[2] and individual values were significantly correlated to those of starch content (R= 0.65; p=0.02) of taro flour. The significant correlation of bulk density with starch reemphasises the fact that starch is the major constituent of taro. This inference is supported by the observation by Tagodoe[2] that modification of taro starch by heat processing affects bulk density of flour.

Blue value index has been used to represent the degree of starch damage or fragility[38]. It has been demonstrated that during processing, molecules of amylose diffuse from partially swollen starch granules [39], which react with iodine to produce the characteristic blue colour that is used in the determination of blue value index. In this study the blue value index of the different flours varied from 6 to 29% with the Ibo Ekona (14.77%) and Ibo Ngdere (28.37%) having the highest index. Based on the results of studies by Suneeta[36] which had shown that the differences in the level of starch damage of potatoes varieties with similar granule ultra structure, it is likely that the observed variation in the blue value index of taro flours may be due to the difference in their starch granular ultra structure, but this need to be investigated. On the other hand, significant correlations were observed between blue value index and amylose content (R=-0.66; p=0.02). This suggests that high-amylose flour exhibit low blue value index or a lower tendency to undergo damage in the course of its being processed. Meanwhile earlier studies by Amani[38] had shown variation in the granular size of two varieties of *Xanthosoma* sp. In addition[1] studying the physical and chemical properties of starches and flours of five varieties of *Colocasia esculenta* in Hawaï had reported that the varieties were different in their granular size (2.60-3.26 μm), in their amylose content (19.6-24.3%) and in their amylopectin chain branch.

The range of oil absorption capacity, 174-186%, of this study is similar to that reported by[2] on Hawaiian taro flour. This range was lower than 290-320% and higher than 73-88% reported, respectively on cowpea and common bean by Njintang and Abbey[13,40]. According to[37], the mechanism of oil retention is due to the physical entrapment of oil. The fat retention was significantly correlated to the emulsion activity (R=0.65; p=0.02). The emulsion activity and stability of taro flour under study were systematically higher than that reported by Njintang[13] on common beans flour. Generally, the formation and stability of emulsion in solutions is due to positives ions, which stabilised the negatives charges of micelles. In this respect, it was though that the presence of proteins ions would favor emulsion stability. However no significant relationship was observed between emulsion stability and protein content.

Under the conditions of the present study, the different varieties of taro flours show significant difference in foaming capacity. Foaming capacity values, which ranged from 9% to 14% was significantly lower than that (27-32%) reported by Tagodoe[2]. Comparatively, the foaming capacity of the taro flour was significantly lower than that of common beans reported by Njintang[13]. Stable foams are known to occur when low surface tension and high viscosity occur at the interface, forming a continuous cohesive film around the air vacuoles in the foam. Soluble proteins in general play an important role on the formation of foam and this probably justify why legumes exhibit higher foaming capacity. In the respect of soluble proteins and foaming, it was observed in this study that foaming capacity is significantly correlated ($R = 0.59$; $p = 0.04$) to the water solubility index. The water solubility index of taro flour varies from 18% for the variety White Country Ngdere to 27% for the variety Red Ibo Ekona. In all cases the index was systematically higher than the value of 9-17% reported by Njintang[13] for the common bean (*Phaseolus vulgaris*). It is important to note here that the soluble matter in taro is mostly due to the mucilage, an arabinogalactan-protein. Up to 13% level of mucilage has been extracted from taro flour by Jiang[41]. However, this protein seems to possess less ability to stabilize foams compared to bean proteins. The foaming properties of the arabinogalactan-protein have not been yet investigated. Mucilage is a fibre and in this respect, a significant correlation ($R = 0.62$; $p = 0.03$) was observed between fibre content and water solubility index of taro flour, further emphasizing the role of arabinogalactan-protein on the water solubility index. It was also observed that amylose content of taro flour was negatively and significantly ($R = -0.77$; $p = 0.03$) correlated to the water solubility index. In fact during flour processing, starch granules sometimes breakdown and amylose is released. The released amylose also contributes to the increase in the water solubility index. That also justifies the significant correlation ($R = 0.81$; $p = 0.00$) between the Blue value (indicate the level of soluble amylose) and the water solubility index. A significant correlation ($R = 0.62$; $p = 0.03$) was also observed between the water solubility index and the pH of the flour solution. The pH levels varied from 6.2 (variety Kwanfre Ngdere) to 7.1 (variety Ibo Ekona). The above correlation suggests that an increase in the pH tends to increase the water solubility of the components in taro. This is true in general as far as the protein solubility is concerned, however the solubility of the most important protein in taro, arabinogalactan-protein, has not yet been investigated.

On the whole, the chemical composition and functional properties of taro flour were observed to vary with variety. Flours made from the different taro varieties studied posses a high water absorption capacity and as such have a good potential of being used in different food processes or as soup bulking agents. The performance of these flours in the preparation of the traditional fufu locally called achu is currently being evaluated.

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