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Chemical Composition And Nutritional Value Of Composite Wheat Flours (*Triticumaestivum*) And Two Varieties Of Taro Corms (*Colocasiaesculenta*) Cultivar Fouê And Cultivar Yatan

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Abstract: *The aim of this study, was to evaluate nutritive potential of composite flours of wheat (Triticumaestivum) and taro corms (Colocasiaesculenta) cv fouê and yatan.*
Moisture and ash contents of composite flours of wheat and taro (cvyatan) increased significantly and were respectively 11.66 ± 0.46 to 11.83 ± 0.23, 2.18 ± 0.02 to 3.60 ± 0.06. Protein values (12.71 ± 0.3 to 11.90 ± 0.83), lipids (1.16 ± 0.07 to 1.12 ± 0.07), carbohydrates (72.51 ± 0.85 to 71.55 ± 0.79) and cellulose (2.24 ± 0.07 to1.03 ± 0.07) decreased significantly.
Moisture contents (11.66 ± 0.46 to 11.83 ± 0.23), ash (2.18 ± 0.02 to 3.60 ± 0.06), lipids (0.98 ± 0.16 to 1.13 ± 0.08) and total sugars (5.90 ± 0.08 to 9.44 ± 0.04) of composite flours of wheat and taro (cv fouê) increase significantly but protein (12.14 ± 0.3 to 11.85 ± 0.3), carbohydrate (72.91 ± 0.7 to 71.41 ± 1.99) and cellulose (2.3 ± 0.07 to 1.00 ± 0.07) values decrease significantly. The major minerals potassium (K) and phosphorus (P) in composite flours of wheat and taro (cv yatan) increased significantly and are respectively 173.95 ± 0.14 to 186.69 ± 0.4, 147.64 ± 0.25 to 181.13 ± 0.02. In composite flours of wheat and taro (cvfouê), their respective contents are 173.5 ± 0.35 to 181.5 ± 0.03, 147.5 ± 0.14 to 173.47 ± 0.01.

Key words: *Colocasia esculenta, Composite flours,Triticumaestivum, Nutritional value*

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I. Introduction

Taro (*Colocasia*spp) is a monocotyledenouns and a member of the araceae family. Taro is widely cultivated in tropical areas of the world such as South East Asia, the Pacific Islands, the Mediterranean, Africa and the United States of America (Nip, 1997). The world production of taro is about 10.3 million tons with Africa producing 9.5 million tons representing 92.2 % (FAO, 2008). Among the African countries, Nigeria is the biggest world producer with more of 4 millions of tons (44% of the world production) then Ghana (1.5 millions of tons), Côte d'Ivoire (more than 350 000 tons) (Bell *et al*., 2000). Taro is a food that can turn into a series of similar foods to those described for cassava and yam such as porridge, fried, foutou, fritters, spicy soup, sweet soup, paste or ball (Hong *et al*., 1990; Njintang*et al*., 2000).

Considering its biochemical value(Aboubakar*et al*., 2008; Kaur *et al*., 2011), taro has been found to be an important ingredient in the production of beverages and for partial replacement of wheat flour in bread, cookies (Nup*et al*., 1994 ; Mongi*et al*., 2011 ; Sanful, 2011).

Wheat (*Triticum* spp.) is the most important stable food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops (Abd-El-Haleem et al., 1998 ; Adams et al. , 2002 ; Shewry et al., 2009). Wheat flour is used to prepare bread, produce biscuits, confectionary products, noodles and vital wheat gluten or seitan (FAO, 2010). Many people like wheat-based products because of the taste, and particularly the texture. Wheat is unique among cereals because its flour possesses the ability to form a visco-elastic dough when mixed with water.

Composite flour defined as a mixture of flours, starches and other ingredients intended to replace wheat flour totally or partially in bakery and pastry products (Milligan *et al*., 1981). Composite flours used were either binary or ternary mixtures of flours from some other crops with or without wheat flour (Shittu *et al.*, 2007). Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown crops as flour (Berghofer, 2000; Hugo *et al.*, 2000; Bugusu*et al.*, 2001, Hasmadi*et al*., 2014). Local raw materials substitution for wheat flour is increasing due to the growing market for confectioneries (Noor Aziah and Komathi, 2009). Thus, several developing countries have encouraged the initiation of programmes to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor*etal*., 2011). The aim of this study was to make wheat-based flours and a local product (*colocasiaesculenta*) and to determine their properties for use in food (pastry, bakery…)

II. Materials and methods

Sample collection

Taro (*Colocasiaesculenta)* corms cvyatan (Figure 1) and cv fouê (Figure 2) physiological maturity were collected in Affery (Southeast, Côte d'Ivoire). Put in a cooler to preserve its fresh state, they were transported to the Laboratory of Biocatalysis and Bioprocessing of University of Nangui Abrogoua (Abidjan. Côte d'Ivoire) where study was conducted.

Figure 1: Taro (*Colocasiaesculenta)*corms cvyatan

Figure 2: Taro (*Colocasiaesculenta)*corms cvfouê

Methods

Preparation of taro flour

The freshly harvested taro corms were thoroughly rinsed with water tap and then peeled. Peeled corms were thoroughly rinsed with tap water peeled then with a knife made of rustproof steel. The peeled corms have been rinsed abundantly to the water of faucet and has been cut in slices with the same knife made of rustproof steel. Slices were plated on aluminum foil at room temperature (28°C) for 20 min and deposited in an oven at forced convection air to a drying process for 48 hours at 45 ± 2°C. After drying, the slices were ground in a Blendor type of hammer mill. The ground material obtained was sieved through a 100 µm mesh sieve. The flour obtained was sealed in polyethylene bags and stored at 25°C in a desiccator until use.

Preparation of composite (taro-wheat) flour

Taro-wheat composite flour was processed by blending wheat and taro (*ColocasiaEsculenta*Cvyatan andfouê) flours. Predetermined proportions of 1. 3. 6. 9 and 12 part by weight of taro flour mixed with 99. 97. 94. 91 and 88 part by weight of wheat flour to obtain 1. 3. 6. 9 and 12% of taro-wheat composite flour respectively. 100% wheat flour was used as a control bread sample. The flours were packed in polythene bags and stored at 25 ° C in a desiccator until use.

Proximate Analysis

Dry matters were determined by drying in an oven at 105ºC during 24 h to constant weight (AOAC. 1990). Crude protein was calculated from nitrogen (Nx6.25) obtained using the Kjeldahl method by AOAC (1990). Crude fat was determined by continuous extraction in a Soxhlet apparatus for 8 h using hexane as solvent (AOAC. 1990). Total ash was determined by incinerating in a furnace at 550ºC (AOAC. 1990). Total carbohydrates were calculated by difference. Method described by Dubois *et al*. (1956) was used to determine total sugars while reducing sugars were analyzed according to the method of Bernfeld (1955) using 3.5 dinitrosalycilic acids (DNS). The crude cellulose contents were determined according to standard method (BIPEA, 1976).

Minerals analysis

Minerals were determined employing AOAC (1990) method. Flour was digested with a mixture of concentrated nitric acid (14.44 mol/L). Sulfuric acid (18.01 mol/L) and perchloric acid (11.80 mol/L) and analyzed using an atomic absorption spectrophotometer. The total of phosphorus was determined by method of Taussky and Shorr (1953) using the reactive vanado-molybdique.

Statistical analysis

All analyses were performed in triplicates. Results were expressed by means of ± standard deviation (SD). Statistical significance was established using Analysis of Variance (ANOVA) models to estimate the Chemical composition and nutritional value of composite flours. Means were separated according to Duncan’s multiple range analysis ($p<0.05$), with the help of the software Statistica (StatSoft Inc, Tulsa USA Headquarters).

III. Results and discussion

Proximate composition

The chemical compositions of wheat flour and composite (wheat-taro) flours are shown in tables 1 and 2. The moisture contents of the wheat flour and composite flours presented in tables 1 and 2 are statistically identical ($p>0.05$). The moisture contents of wheat flour of composite flours of wheat and taro corms of *colocasiaesculenta* cv yatan (Table 1)ranged between 11.66±0.46 (FB) to 11.83±0.23 (FCY_{12}) and 11.66±0.46 (FB) to 11.88±1.55(FCF_{12}) (Table 2). These low moisture contents of flours would be due to the efficiency of the drying methods used (Pierre, 1989). Indeed, it is well established that high moisture superior at 12% of food products promotes susceptibility to microbial growth and enzyme activity which accelerates spoilage (Brock *et al*., 1986 ; Ndangui, 2014 ; Anno *et al*., 2016). Moisture content is an index of storage of the flours.

Flours moisture contents less than 14 % can resist microbial growth and contribute to best storage (Colas, 1998; Okonkwo and Opara. 2010). Similar observation were made by Matter (2015) in wheat-sweet potato composite flours.

Ash flours contents presented in tables 1 and 2 differ significantly ($p < 0.05$) from cvyatan to cv fouê. The values of table 1 ranged between 2.13±0.06 (FB) to 3.6±0.06 (FCY_{12}) and 2.13±0.06 (FB) to 3.73±0.06 (FCF_{12}) (Table 2). These ash contentswere superior to those reported by Meite*et al*. (2008) in wheat-*citrulluslanatus*composite flours (1.53±0.04% to 2.33±0.13%). Incorporation of taro flour in wheat flour increased the ash contents.

The protein contents of the wheat flours (13.34±0.30 %) (Tables 1 and 2)were higher thancomposite flours 11.73±0.30(FCY_9) to 12.71±0.3 (FCY_1) and 11.85±0.3 (FCF_{12})to 12.14±0.30(FCF1). These resultsare similar than reported by Igbabul*et al*. (2014) in breads produced from wheat- potato composite flours.Plant which produse more than 12% of protein are a good source of proteins (Ali, 2009).

The fat content ofwheat flour and wheat-taro composite flours (Table1) were statistically identical ($p>0.05$) and ranged between 0.98±0.16(FCF) to 1.19±0.07(FB). In table 2, the fat content of flours differ significantly ($p < 0.05$) and ranged between 1.12±0.01 (FCY_{12}) to 1.19±0.07 (FB). The wheat flour had the higher rate of fat than the composite flours. These results corroborate the findings of many authors who showed that vegetables are poor sources of fat (Ejoh*et al*., 1996). The fat contents of wheat-taro composite flours were lower to those mentioned by Diallo *et al*. (2015) in wheat-voandzoucomposite flours (6.90±2.38% to 9.91±1.82%).

Carbohydrate are major compound in flours. The carbohydrate contents obtained in the composite flours were relatively high. These values ranging between 71.55±0.79 (FCY_{12}) to 73.38±0.83 (FB) (Table 1) and 71.86±0.58 (FCF9) to 73.38±0.83 (FB) (Table 2) . The high carbohydrates content in the flours is a proof of their being highly nutritious and good for human consumption. These carbohydrate contents are superior to those reported by Igbabul*et al*. (2014) in composite bread produced from wheat, maize and orange fleshed sweet potato flours(52.18±0.02% to 53.35±0.01%).

The cellulose content of composite flours ranged from 1.03±0.07 % (FCY12) to2.4±0.07 (FB) (Table 1) and 1.00±0.07 (FCF_{12}) to 2.4±0.07 (FB) (Table 2). The cellulose is important in the man's food. indeed cellulose consumption also soften stools and lowers plasma cholesterol level in the body (Verma and Banerjee, 2010). Also they will be able to contribute to the reduction of the cardiovascular risk (Streppel*et al*, 2008), of the blood pressure (Lee *et al*., 2008). These food cellulose could be used them like ingredients to improve the Water absorption capacity, the oil absorption capacity and the viscosity of food (Muhammad*et al*., 2011).

Mineral composition of flours (wheat-flour and composite flours) are shown in Tables 3 and 4. Mineral elements are essential for human health, have important physiological roles on different organs and cellular mechanisms.

The two dominant minerals in flours are phosphorus (P) and potassium (K). The least dominant are copper (Cu), zinc (Zn) and manganese (Mn).

The phosphorus contents of flours ranged between 147.37±0.05% (FB) to 181.13±0.02% (FCY_{12}) (Table 3) and 147.37±0.05% (FB) to 173.47±0.01 (FCF_{12}) (Table 4). The potassium contents of flours ranged between 173.16±0.11(FB) to 186.69±0.43 (FCY12) (Table 3) and 173.16±0.11(FB) to 181.5±0.03(FCF_{12}) (Table 4).

The presence of taro flours in wheat flour induced a Significant increase ($p <0.05$) of the minerals contents in composite flours (Tables 3 and 4). The increase of minerals values in composite flours could be due to the degree of maturity of the different cultivars of the taro (*Colocasiaesculenta*). Indeed, according to Huang et al. (2007), an increase of concentration metals in the taro is function of the degree of maturity of this one. Phosphorus values obtained were higher than those reported byMakanju and Awogbenja (2012) (99.7±0.17 and 129.7±33 mg/100g) on the complementary food in Nigéria

Table 1: Proximate chemical composition (g/100 g of dry matter) of wheat flour and composite flours of wheat and taro corms of *colocasiaesculenta*cvyatan

Substances nutritionnelles organiques (%)	FB	FCY1	FCY3	FCY6	FCY9	FCY12
Moisture	11.66±0.46^a	11.66±0.46^a	11.66±0.11^a	11.70±0.23^a	11.77±0.72^a	11.83±0.23^a
Ash	2.13±0.06^a	2.18±0.02^b	2.42±0.06^c	2.40±0.06^d	2.99±0.02^e	3.60±0.06^f
Protein	13.34±0.30^d	12.71±0.30^c	12.31±0.43^b	12.09±0.30^b	11.73±0.30^a	11.90±0.43^a
Fat	1.19±0.07^c	1.16±0.07^b	1.14±0.02^a	1.14±0.11^a	1.12±0.17^a	1.12±0.07^a
Sugar	5.57±0.04^a	5.59±0.06^a	6.402±0.15^b	7.13±0.02^c	8.08±0.08^d	8.35±0.03^d
Carbohydrate	73.38±0.83^b	72.51±0.85^b	72.62±0.62^b	72.69±0.70^b	72.4±1.21^b	71++.55±0.79^a
Cellulose	2.4±0.07^e	2.24±0.07^d	2.18±0.07^d	1.94±0.07^c	1.74±0.07^b	1.03±0.07^a

Results are expressed in a dry weight basis In each line different letters mean significant differences ($p < 0.05$).
FB:Flour of wheat
FCY1: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan, proportion 99/1 (p/p)
FCY3: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan, proportion 97/3 (p/p)
FCY6: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 94/6 (p/p)
FCY9: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 91/9 (p/p)
FCY12: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 88/12 (p/p)

Table 2: Proximate chemical composition (g/100 g dry matter) of wheat flour and composite flours of wheat and taro corms of *colocasiaesculenta*cvfouê

Substances nutritionnelles organiques (%)	FB	FCF1	FCF3	FCF6	FCF9	FCF12
Moisture	11.66±0.46[a]	11.66±0.20[a]	11.68±0.30[a]	11.73±0.69[a]	11.81±0.17[a]	11.88±1.55[a]
Ash	2.13±0.06[a]	2.31±0.04[b]	2.57±0.05[b]	2.61±0.07[c]	3.34±0.06[d]	3.73±0.06[e]
Protein	13.34±0.30[c]	12.14±0.30[b]	11.91±0.30[a]	11.89±0.30[a]	11.89±0.30[a]	11.85±0.30[a]
Fat	1.19±0.07[a]	0.98±0.16[a]	1.01±0.17[a]	1.09±0.05[a]	1.10±0.05[a]	1.13±0.08[a]
Total sugar	5.57±0.04[a]	5.90±0.08[b]	6.63±0.05[c]	7.88±0.06[d]	8.33±0.03[e]	9.44±0.04[f]
Carbohydrates	73.38±0.83[c]	72.91±0.70[b]	72.83±0.82[b]	72.68±1.11[b]	71.86±0.58[a]	71.41±1.99[a]
Cellulose	2.4±0.07[d]	2.3±0.07[d]	2.26±0.4[d]	2.01±0.07[c]	1.83±0.03[b]	1.00±0.07[a]

Results are expressed in a dry weight basis In each line different letters mean significant differences ($p < 0.05$).
FB: Flour of wheat
FCF1: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 99/1 (p/p)
FCF3: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 97/3 (p/p)
FCF6: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 94/6 (p/p)
FCF9: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 91/9 (p/p)
FCF12: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 88/12 (p/p)

Table 3 : Minerals concentrations (mg/100 g on dry weight basis) of wheat flour and composite flours of wheat and taro corms of *colocasiaesculenta* cv yatan

Flour of wheat and Composite flour		FB	FCY1	FCY3	FCY6	FCY9	FCY12
Macro-minerals	Mg	26.33±0.58	26.83±0.23a	30.89±0.75b	36±0.18c	41.83±0.34d	42.83±0.32e
	Na	5.18±0.02	5.86±0.12a	6.11±0.04b	6.40±0.11b	6.51±0.16b	6.52±0.23b
	K	173.16±0.11	173.95±0.14a	177.16±0.11b	186.11±0.11c	186.66±0.04c	186.69±0.43c
	Ca	30.81±0.01	30.91±0.05a	38±0.07b	38.34±0.02b	38.62±0.05b	38.67±0.05b
	P	147.37±0.05	147.64±0.25a	169.56±0.04b	171.41±0.07c	171.64±0.03c	181.13±0.02d
Micro-minerals	Cu	0.12±0.02[a]	0.13±0.01[b]	0.13±0.07[b]	0.15±0.04[c]	0.16±0.04[d]	0.18±0.04[e]
	Zn	0.73±0.03[a]	0.74±0.09[b]	0.83±0.11[c]	0.87±0.11[d]	0.89±0.23[e]	0.94±23[f]
	Fe	1.00±0.02[a]	1.05±0.04[b]	1.10±0.02[c]	1.13±0.03[d]	1.14±0.04[e]	1.16±0.03[f]
	Mn	0.71±0.10[a]	0.71±0.04[a]	0.73±0.16[b]	0.74±0.01[c]	0.80±0.01[d]	0.84±0.11[e]

Results are expressed in a dry weight basis In each line different letters mean significant differences ($p < 0.05$).
FB:Flour of wheat
FCY1: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan, proportion 99/1 (p/p)
FCY3: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan, proportion 97/3 (p/p)
FCY6: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 94/6 (p/p)
FCY9: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 91/9 (p/p)
FCY12: Composite flour of wheat and taro corms of Colocasiaesculentacvyatan proportion 88/12 (p/p)

Table 4 : Minerals concentrations (mg/100 g on dry weight basis) of wheat flour and composite flours of wheat and taro corms of *colocasiaesculenta* cv fouê

Flour of wheat and Composite flour		FB	FCF1	FCF3	FCF6	FCF9	FCF12
Macro-minerals	Mg	26.33±0.58	26±0.07a	25.83±0.22b	25.5±0.70b	24.5±0.35c	24.33±0.47c
	Na	5.18±0.02	5.00±0.07a	4.85±0.15b	4.5±0.35c	3.75±0.28d	3.49±0.14e
	K	173.16±0.11	173.5±0.35a	175.66±0.66b	175.83±0.02b	180.83±0.73c	181.5±0.03c
	Ca	30.81±0.01	30.24±0.03a	29.08±0.06b	28.92±0.72c	28.81±0.22c	27.59±0.07d
	P	147.37±0.05	147.5±0.14a	155.12±0.01b	167.37±0.05c	170.36±0.04d	173.47±0.01e
Micro-minerals	Cu	0.12±0.02[a]	0.12±0.01[a]	0.13±0.05[a]	0.14±0.02[a]	0.15±0.01[b]	0.16±0.04[b]
	Zn	0.73±0.03[a]	0.73±0.02[a]	0.75±0.01[b]	0.83±0.06[c]	0.85±0.05[d]	0.90±0.09[e]
	Fe	1.00±0.02[a]	1.11±0.03[b]	1.16±0.04[c]	1.18±0.03[d]	1.21±0.17[e]	1.23±0.07[f]
	Mn	0.71±0.10[a]	0.72±0.01[b]	0.73±0.16[c]	0.75±0.01[d]	0.81±0.02[e]	0.86±0.46[f]

Results are expressed in a dry weight basis In each line different letters mean significant differences ($p < 0.05$).
FB: Flour of wheat
FCF1: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 99/1 (p/p)
FCF3: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 97/3 (p/p)
FCF6: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 94/6 (p/p)
FCF9: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 91/9 (p/p)
FCF12: Composite flour of wheat and taro corms of Colocasiaesculentacv "fouê", proportion 88/12 (p/p)

IV. Conclusion

Composite flour shows good potential for use as a functional agent in bakery products, therefore the evaluation of the functionality of composite flour in test baking should be performed to ensure an increase in the use of composite flour made from many different raw materials in future. This study shows that taro (*Colocassiaesculenta*) can be successfully introduced in the formulation of composite flours, which are low cost and easy to prepare. This is a new method of valuing this very important crop in the diets. The stability of the obtained flours should be further studied.

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