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COMPARATIVE STUDIES ON PROXIMATE COMPOSITIONS AND FUNCTIONAL PROPERTIES OF TRIFOLIATE YAM FLOUR VARIETIES

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Abstract: The effect of drying methods on proximate composition and functional properties of Trifoliate Yam were investigated. The sample was dried using sun and oven drying methods. The dried sample were later milled and sieved with standard sieve for effective results. Association of Official Analytical Chemist (A.O.A.C) standard methods were used to determine the functional properties and proximate analysis of Trifoliate Yam flour sample. The results indicated that nutritional composition showed a high level of protein, carbohydrates (dietary fibre) for Oven dried sample while the high level of fat were noticed at Sun dried sample which are essential for man and livestock. The functional properties showed that these Trifoliate Yam displayed diverse functional characteristics. From the studies it is believe that the Trifoliate Yam flour have both great nutritional and functional values which could be used to meet the nutritional needs of the populace. Therefore, when functional properties and proximate composition of the sample are concerned the Oven drying method give a better functional and nutritional values. The ANOVA showed that Oven drying had significant effect on the functional properties and proximate composition across the specie tested.

***Key words**: Functional properties, proximate composition, trifoliate yam, drying methods.*

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INTRODUCTION

Yam (*Dioscorea* sp.) is one of the most important food crops in West Africa especially Nigeria and is well accepted as a staple food in most homes [18]. Yams are both annual and perennial tuber-bearing and climbing plants with more than 600 species in which only few are cultivated for food and medicine [13]. The most cultivated species in Nigeria are the white yam (*D. rotundata*), yellow yam (*D. cayenensis*), water yam (*D. alata*) and trifoliate yam (*D. dumetorum*) [7]. Trifoliate yam (*Dioscorea dumetorum*) is however underutilized yam among the species. The tubers are eaten during the time of famine or scarcity and are usually boiled with the peel and eaten as boiled yam.
Trifoliate yam hardens few days after harvest and this leads to reduction in moisture and starch content and increase in sugars and structural polysaccharides [5].

Triofoliate yam has been reported to be nutritionally superior to the commonly consumed yams with high protein and mineral content [14]. In an attempt to explore these benefits and to add more value to *D. dumetorum* as an important source of food and energy, [15], [16] developed schemes for processing of its hardened tubers into flours and suggested that these flours can be used in bakery. Some literature has been reported by some authors [20]; [4]*;* [9]*;* [12]; [8]; [10] and [3] on the chemical composition of Trifoliate yam flour using different processing methods but no literature was cited on the effect of different drying methods on the functional properties and proximate composition of three varieties of trifoliate yam flour dominant in Nsukka, Enugu State, Nigeria. Therefore, there is need to increase utilization of yam through industrial processing to minimize post-harvest losses which in turn may lead to increased earnings from this crop. The starch content of the tuber presents prospects for the processing of yams into starches. Currently, yams are not listed among the most common sources of industrial starch which is principally provided by corn, potato, wheat, tapioca and rice [12]. Starch is an important raw material for a number of industries including textiles, paper, adhesives, pharmaceuticals and food. As a country becomes more industrialized, demand for both native and modified starches increases but these demand are rather met through imports instead of locally made starch. D. *dumentorum spp* is not a widely studied variety. The post-harvest hardening phenomenon problem has an adverse effect on the productivity of the yam. Starch production and evaluation is therefore carried out in order to improve the utilization of trifoliate yam locally and industrially. This will reduce dependence on starch importation and thus increase the industrial utilization from locally available raw material. The result from this research will benefit the breeders, processors and other researchers. The objective of this work therefore is to evaluate the effect of drying methods on functional properties and proximate composition from three varieties of trifoliate yam flour.

MATERIALS AND METHODS

The three cultivars of trifoliate yam (yellow, white and deep-yellow) were obtained from a local farm in Obolla-Afor, in Udenu Local Government Area of Enugu State, Nigeria.

Figure 1. Trifoliate Yam sample used for the experiment

PREPARATION OF TRIFOLIATE YAM FLOUR

The tubers were washed with distilled water, peeled and sliced at uniform thickness of 10mm using stainless kitchen knife .The slices were drained using plastic sieve and then divided into two equal batches of the same quantity. First batch of the slices of the three varieties of Trifoliate Yam were dried in hot air oven (Multi-Purpose Oven (Model OKH-HX-1A) China) at 70°C with the weight being measured at interval of 20 minutes until a constant weight was obtained. Second batch was sun-dried for 4 days at 29-30°C and 60 - 70% relative humidity. The six dried Trifoliate Yam samples were milled into flour using hammer mill, packaged in polythene bags, sealed and then stored in air tight containers with appropriate labeling and then carried to the laboratory were, functional properties and proximate composition was investigated.

DETERMINATION OF FUNCTIONAL PROPERTIES OF THE TRIFOLIATE YAM FLOUR

Functional characteristics of food products are the food parameters that measure food application and its end use. It usually tells how the biomaterials under test will respond to other food components either directly or indirectly affecting food quality, processing applications and ultimate acceptance [11].

This study narrowed its interest on some functional properties like swelling power, solubility, bulk density, foaming capacity, oil and water absorption capacity, emulsification and gelatinization.

Gelation (%).

In a test tube, a sample suspension of 2.20% (w/v) in 5ml of distilled water was prepared in test tubes. The sample was heated in boiling water bath at 60mins and rapidly cooled in a bath of cold water. The test tube was allowed to cool for the next two hours at 40^0C. The gelation capacity which is the least gelation concentration measured when the concentration of the sample from the inverted test tube will not fall. This method was reported by [19].

Emulsification capacity (%)

EC was measured by addition of (2g) of the flour sample with 100ml of distilled water which was blended for 30sec at 100rpm speed. After complete diffusion, peanut oil was added from a burette in streams of about 5ml. Blending persist until the blend separate into two distinct layers. Then emulsion capacity was determined as grams of oil emulsified by 1g flour. Triplicate measurements will be made and average results taken. This method was adopted by [11].

Foaming capacity (%)

Foaming capacity was measured by adding 2g of flour sample in a 50ml of distilled water in a 100 ml measuring cylinder. The mixed sample was properly shake to foam and the maximum volume after 30s was recorded. The foaming capacity of the sample was the percentage increase in volume after 30s.This was reported by [11].

Oil absorption capacity (OAC)

The mixture of 1g of flour with 10 ml refined corn oil in a centrifuge tube allowed to stand at room temperature 30 ± 2°Cfor 60mins It was centrifuged at 1600g for 20min. The volume of free oil was noted and poured. Fat absorption capacity was measured as ml of oil bound by 100g dried flour [11].

Water absorption capacity (%)

In 15 ml centrifuge tube 1g of the flour was weighed and poured in 10ml measuring cylinder of water. It was shaken on a platform tube rocker for 1 minute at room temperature. The sample was allowed to stand for 30 min and centrifuged at 1200g for30 min. The volume of free water was read directly from the centrifuge tube.

Swelling power (SP)

According to [22]., 3g of the flour sample was partitioned and each part of the dried flour was transferred into clean, dry, calibrated 50ml cylinders. Flour samples were slightly leveled and their volumes were recorded. 30ml distilled water was added to each sample then the cylinder was allowed to be swirled and stand for 60 minutes while the swelling power (change in volume) was recorded at 15 minutes interval.

The swelling power of each flour sample was calculated at interval of 15 minutes at each volume raised.

Solubility (%)

Cold water extraction method was used to determine solubility. The flour was divided into 10% w/v (db) was prepared with each of the flour samples by dissolving it in 1g (db) of flour in 5ml distilled water measuring cylinder and adding it up to 10ml. the sample allowed for 60 minutes and stirred at each 10 minutes. The sample was allowed to settle for 15 minutes after 2ml of the supernatant were measured in a dry Petri dish evaporated to dryness and re-weighed. The change in mass is the total soluble solids and this was calculated using the equation reported by [21].

$$Solubility = TSS(\%)\frac{(VsMe - Md)}{2MS1}x\ 100 \quad \ldots\ldots (1)$$

Vs = Total supernatant/ filtrate;
Md= Mass of empty, dry Petri dish;
Me = Mass of Petri dish plus residual solid after evaporative drying.

DETERMINATION OF PROXIMATE COMPOSITION OF THE TRIFOLIATE YAM

Proximate analysis of bio-materials describe the basic nutrient composition of the bio-material in terms of crude protein, moisture content, fat, ash, fiber and carbohydrate. The flour samples were analyzed for moisture content, dries matter, crude protein, crude fiber, fat, ash and carbohydrate using Approved Methods of The American Association of Cereal Chemist [2]. All the chemicals were of analytical concentration.

The moisture content of the samples where determined using the procedure described by [2].The moisture content was determined by weighing 5g of the flour sample into aluminum Can. The sample was then dried to a constant weight at 105.

$$\boldsymbol{MC = \frac{W_w - W_D}{W_D} X\ 100\%} \quad \ldots\ldots (2)$$

Where:
MC = moisture content (%);
W_w = weight of wet sample (g);
W_D = weight of dry sample (g)

The crude fiber was determined using Method [1]. This involves transferring 2g of the sample into 1litre of conical flask. Then heating 100ml of water until it boils and pouring it into the conical flask that contains the samples, the mixture were then boiled together for about 30 minutes.

After boiling for 30 minutes, the mixture was filtered using a Muslin cloth held in a funnel. The residue was thoroughly rinsed until it was no longer alkali. The residue was then poured into an already dried crucible and ached at 600°C ± 200°C. The crude fiber was evaluated using the equation below.

$$\boldsymbol{Crude\ fiber}\ \frac{\boldsymbol{weight\ of\ crucible}}{\boldsymbol{weight\ of\ the\ sample}}\ \boldsymbol{X\ 100}\% \tag{3}$$

Determination of the Ash Content

The ash content represents the mineral or organic residue of a bio-material. It gives an idea of the amount of total mineral content of the food material**.** The ash content was determined using [1], [6].

$$\boldsymbol{Ash\ content}(\%) = \frac{\boldsymbol{weight\ of\ Ash}}{\boldsymbol{weight\ of\ sample}}\ \boldsymbol{X100}\% \tag{4}$$

Determination of Crude Fat Content

The Crude Fat content was evaluated using procedure proposed by [6] by using Soxhiet extractor with Hexane. 1g of the samples was measured into a thimble extractor placed into extraction chamber with some Hexane added to extract the fat. The fat was evaluated using equation below

$$\boldsymbol{Crude\ fat}(\%) = \frac{\boldsymbol{weight\ of\ fat}}{\boldsymbol{weigth\ of\ sample}}\ \boldsymbol{X\ 100}\% \tag{5}$$

Determination of Crude Protein

Protein is amino acids joined together by peptide linkage. They contain essential elements such as Carbon, Hydrogen, Oxygen and Nitrogen etc. The Crude Protein was evaluated using Foss Desiccators, Protein Digester and KJECTEC2200 Distillation apparatus using [1], [6] procedure.

$$\boldsymbol{Crude\ protein} = (\boldsymbol{Titre\ value\ of\ the\ sample} - \boldsymbol{Blank})\boldsymbol{X}\,\frac{\mathbf{0.01}\boldsymbol{X}\ \mathbf{14.007}\ \boldsymbol{X}\ \mathbf{6.25}\ \boldsymbol{X}\ \mathbf{100}}{\mathbf{1000}\ \boldsymbol{X\ weight\ of\ thesample}} \tag{6}$$

RESULTS AND DISCUSSION

Effect of Drying Methods on Functional Properties of Trifoliate Yam Flour

Figure 1-2 and Table 1., shows the functional properties of the trifoliate yam species based on the drying methods selected. The results obtained from Oven drying method are 0.57 (g/ml), 3.15(g/g), 2.82(g/g), 2.06(g/g), 12.00(%), 19.60(%), 24.86(%), 12.76 (%) for WTY, 0.63(g/ml), 4.68(g/g), 2.80(g/g), 3.90(g/g), 6.00(%), 24.72(%), 23.45(%), 10.70(%) for YTY, 0.42(g/ml), 3.53(g/g), 1.75(g/g), 3.00(g/g), 10.00(g/g), 18.72(g/g), 14.83(%), 10.60(%) for DYTY and the properties tested where;

bulk density, swelling index, oil and water absorption capacity, gelation capacity, foaming capacity, emulsification capacity, solubility respectively.

While the result obtained from Sun drying were 0.57(g/ml), 2.96(g/g), 2.14(g/g), 1.70(g/g), 8.00(%), 23.60(%), 19.76(%), 13.50(%) for WTY, 0.64(g/ml), 3.84(g/g), 2.75(g/g), 3.80(g/g), 6.00(%), 21.76(%), 22.65(%), 9.24(%) for YTY, 0.43(g/ml), 4.04(g/g), 2.85(g/g), 1.68(g/g), 8.00(%), 21.72(%), 24.83(%), 10.28(%) for DYTY and the properties tested were; bulk density, swelling index, oil and water absorption capacity, gelation capacity, foaming capacity, emulsification capacity, solubility respectively. It was observed that high values were obtained for emulsification and gelation capacity and also solubility for both drying methods with the highest being for emulsification. Other properties varied and bulk density was observed to have the lowest value for both drying methods. Given the similarities in the values of functional properties it can be inferred that specie have very little effect on the functional properties of the samples tested. The significant values of gelation capacity were an indication of protein in the samples despite it being a tuber. This is in line with what was opined by [17] that increase in concentration of protein in a sample increases its gelation property.

Table 1. Functional Properties of Three Different Species of Trifoliate Yam

Drying method	*Sample name*	*Bulk dens. (g/ml)*	*Swelling Index*	*Oil absorp. cap. (g/g)*	*Water absorp. capacity (g/g)*	*Gelation capacity (%wt/vol)*	*Foaming capacity (%)*	*Emulsif. capacity (%)*	*Solubility*
VEN DRIED	*WTY*	*0.57*	*3.15*	*2.82*	*2.06*	*12.00*	*19.60*	*24.86*	*12.76*
	YTY	*0.63*	*4.68*	*2.80*	*3.90*	*6.00*	*24.72*	*23.45*	*10.70*
	DYTY	*0.42*	*3.53*	*1.75*	*3.00*	*10.00*	*18.72*	*14.83*	*10.60*
SUN DRIED	*WTY*	*0.57*	*2.96*	*2.14*	*1.70*	*8.00*	*23.60*	*19.76*	*13.50*
	YTY	*0.64*	*3.84*	*2.75*	*3.80*	*6.00*	*21.76*	*22.65*	*9.24*
	DYTY	*0.43*	*4.04*	*2.85*	*1.68*	*8.00*	*21.72*	*24.83*	*10.28*

WTY White Trifoliate Yam, YTY Yellow Trifoliate Yam, DYTY Deep-Yellow Trifoliate Yam.

The ANOVAs for functional properties of the tested samples. It can be observed that for both drying methods, the F-values for between species variations were found to be lower than the F-critical values (1.4 and 0.14 < 3.74). We therefore accept the null hypothesis. This means that neither the employed drying methods nor difference in species significantly affected the functional properties. However, within each trifoliate yam species there were statistically significant variations as seen in the F-values (32.32 and 106.20 > 2.76). The alternate hypothesis is accepted in both these cases.

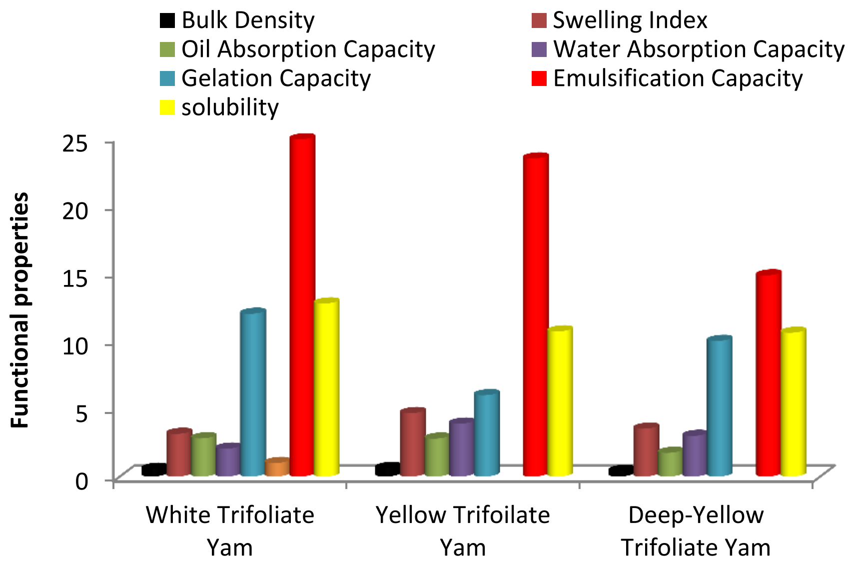

Figure 1. Effect of Oven drying on Functional properties of Trifoliate Yam Varieties

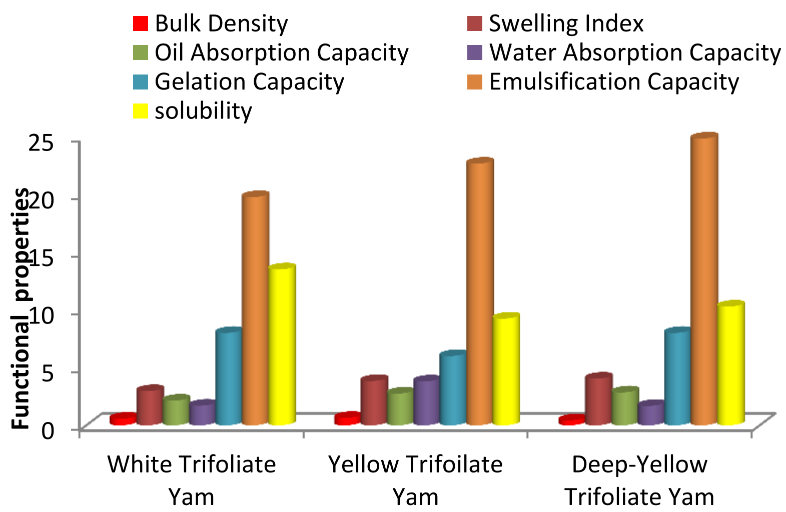

Figure 2. Effect of Sun drying on Functional properties of Trifoliate Yam Varieties

Effect of Drying Methods on proximate composition of Trifoliate Yam Flour

The proximate composition of the three species of the trifoliate yam samples are shown in figures 3-4 and Table 4**.**

The result obtained from Oven drying method were 6.80(%), 93.20(%), 1.69(%), 5.96(%), 10.76(%), 1.83(%), 291.60(kJ), 72.90(%) for WTY, 10.52(%), 89.48(%), 2.12(%),4.76(%), 9.60(%), 2.19(%), 270.29(kJ), 65.45(%) for YTY, 10.28(%), 89.72(%), 1.75(%), 4.85(%), 8.45(%), 21.13(%), 290.16(kJ), 72.54(%) for DYTY and the properties tested were dried matter, ash content, crude protein, fat, crude fiber, energy and carbohydrate respectively. While the result obtained from Sun drying method were 6.84 (%), 93.16(%), 1.80(%), 4.86(%), 19.45(%), 2.42(%), 258.70(kJ), 62.70(%) for WTY, 9.70(%), 90.30(%), 1.92(%), 3.90(%), 9.40(%), 2.18(%), 292.42(kJ), 65.43(%) for YTY, 11.45(%), 88.55(%), 1.76(%), 5.60(%), 10.60(%), 2.24(%), 273.20(kJ), 68.30(%) for DYTY and the properties tested were dried matter, ash content, crude protein, fat, crude fiber, energy and carbohydrate respectively. Dried matter and Carbohydrate were observed to be more in all species and for both drying methods. Similar values obtained for proximate parameters show that neither drying methods nor species had much effect on the proximate composition of the tested trifoliate yam samples.

Table.4. Proximate Analysis of Three Different Species of Trifoliate Yam

Drying method	*Sample name*	*Moisture content*	*Dried matter*	*Ash content*	*Crude protein*	*Fat*	*Crude fiber*	*Energy*	*CHO*
VEN DRIED	*WTY*	*6.80*	*93.20*	*1.69*	*5.96*	*10.76*	*1.83*	*291.60*	*72.90*
	YTY	*10.52*	*89.48*	*2.12*	*4.76*	*9.60*	*2.19*	*270.28*	*65.45*
	DYTY	*10.28*	*89.72*	*1.75*	*4.85*	*8.45*	*2.13*	*290.16*	*72.54*
SUN DRIED	*WTY*	*6.84*	*93.16*	*1.80*	*4.86*	*19.45*	*2.42*	*258.70*	*64.70*
	YTY	*9.70*	*90.30*	*1.92*	*3.90*	*9.40*	*2.18*	*292.42*	*65.43*
	DYTY	*11.45*	*88.55*	*1.76*	*5.60*	*10.60*	*2.24*	*273.20*	*68.30*

WTY White Trifoliate Yam, YTY Yellow Trifoliate Yam, DYTY Deep-Yellow Trifoliate Yam

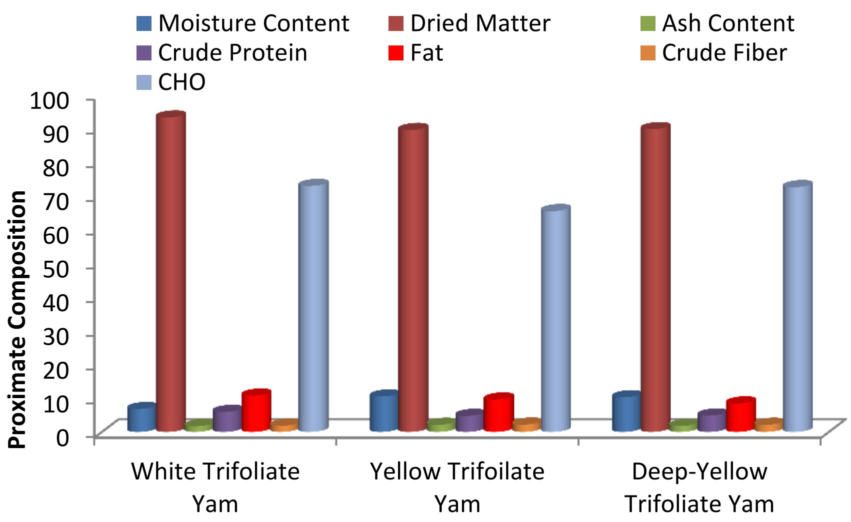

Figure 3. Effect of Oven drying on Proximate Composition of Trifoliate Yam Varieties

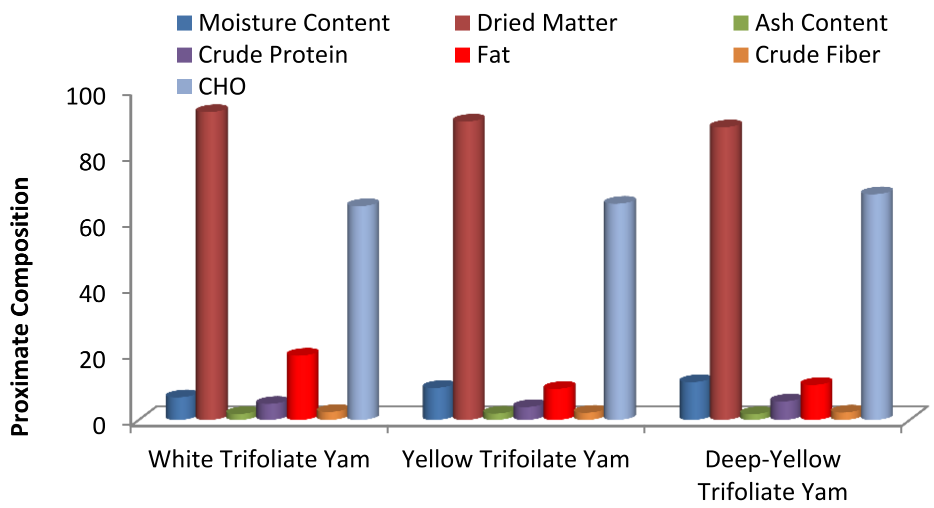

Figure 4. Effect of Sun drying on Proximate Composition of Trifoliate Yam Varieties

The ANOVA's for proximate composition (tables 5 and 6) followed similar pattern with those of functional properties. Both drying methods had F-values for variation between species lower than F-critical values (1.69 and 0.38< 3.73).

For variation within species, both methods also had higher F-values than F-critical (1447.64 and 587.93 > 2.76). We therefore accept the null hypothesis for variation between species and reject it for variation within.

CONCLUSION

From the results and analysis carried out in this study we can conclude on the following;

The results obtained from this work have given an insight of the nutritional and functional properties of three different of Trifoliate Yam species. The nutritional composition showed a high level of protein, carbohydrates (dietary fibre) for Oven dried sample while the high level of fat were noticed at Sun dried sample which are essential for man and livestock. The results of the studies on functional properties showed that these Trifoliate Yam displayed diverse functional characteristics.

From the studies it is believe that the Trifoliate Yam flour have both great nutritional and functional values which could be used to meet the nutritional needs of the populace. Therefore, it is advised to apply oven drying method when the proximate composition and functional characteristics of the flour sample are concerned, because it give a better functional and nutritional values. The ANOVA showed that Oven dry method had significant effect on the functional properties and proximate composition across the specie tested.

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KOMPARATIVNA STUDIJA SASTAVA I FUNKCIONALNIH OSOBINA BRAŠNA OD TROLISNIH VARIJETETA YAMA

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Sažetak: Istraženi su uticaji metoda sušenja na neposredni sastav i funkcionalna svojstva trolisnih varijeteta Yam kulture. Uzorak se suši korišćenjem metoda prirodnog sušenja i sušenja u sušari. Osušeni uzorak je kasnije samleven i prosejan standardnim sitom za efektne rezultate. Za određivanje funkcionalnih svojstava i neposredne analize uzorka brašna trolisne Yam kulture upotrebljene su zvanične standardne metode Asocijacije analitičke hemije (A.O.A.C). Rezultati su pokazali da prehrambeni sastav uzoraka pokazuje visok nivo proteina, ugljenih hidrata (dijetalnih vlakana) za uzorak sušen u peći (sušari), dok je visok nivo masti konstatovan u uzorku sušenom na suncu (prirodnim putem), koji je neophodan za čoveka i stoku.

Funkcionalna svojstva pokazaju da trolisni varijeteti kulture Yam pokazuju različite funkcionalne karakteristike. Studija pokazuje da brašno trolisnih varijeteta Yam ima velike hranjive i funkcionalne vrednosti koje bi se mogle koristiti za ispunjavanje nutritivnih potreba stanovništva. Zato, kada su u pitanju funkcionalna svojstva i neposredni sastav uzorka, metoda sušenja u sušarama daje bolje funkcionalne i hranjive vrednosti.

Rezultati ANOVA analize pokazuju da sušenje u sušarama ima značajan uticaj na funkcionalne osobine, neposredni sastav i kompoziciju za sve ispitivane varijetete kulture Yam.

Ključne reči*: Funkcionalna svojstva, neposredni sastav, trolisni Yam, metode sušenja.*

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