CHEMICAL COMPOSITION, COLOUR, FUNCTIONAL AND PASTING PROPERTIES OF ORANGE-FLESHED SWEET POTATO, *PLEUROTUS TUBERREGIUM* SCLEROTIUM AND THEIR FLOUR BLENDS

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Abstract
Increasing emphasis is being laid on the search for readily available agricultural products which can compete favourably with or surpass wheat in terms of functionality and nutritional composition. Fresh orange-fleshed sweet potato (OFSP) and Pleurotus tuberregium sclerotium were subjected to proximate, sugar, colour and functional analyses prior to processing into flour. Drying increased the proximate, sugar and functional properties but reduced the lightness (L), redness (a*) and yellowness (b*) of the samples. The flour samples were mixed into five different ratios (100:0, 90:10, 80:20, 70:30 and 0:100) with 100% wheat flour as the control. The chemical, functional and pasting properties of the flour blends were evaluated. Significant (p<0.05) differences existed among the proximate composition, sugar content, colour and functional properties of the samples. The protein, ash, crude fibre, colour L*, water absorption capacity, oil absorption capacity, pasting temperature and peak time of the composite flour increased while moisture, fat, carbohydrate, fructose, glucose, sucrose, colour a*, colour b*, bulk density, swelling index, solubility, peak and setback viscosities decreased with increase in the level of sclerotium flour substitution. The sclerotium substituted OFSP flour blends compete favourably well with wheat flour in terms of chemical and functional qualities. The use of these flour blends in food development will not only aid in combating malnutrition but will also enhance OFSP and sclerotium utilization while reducing wheat importation and thus, ensure food security.*

Keywords: Flour blends, OFSP, Pasting properties, Physicochemical properties, Pleurotus tuberregium sclerotium, Sugar composition

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1. INTRODUCTION

The high cost of wheat importation coupled with the necessity to combat malnutrition such as vitamin A deficiency and protein-energy malnutrition has called for the development of food ingredients from cheap and readily available food commodities. In Nigeria, wheat flour is being used for the production of bread, biscuits, cookies and other baked products (Kumar et al., 2011). However, wheat production is limited in Nigeria due to its climatic requirements and this would require huge amount of foreign exchange for its importation. Therefore, it is necessary to seek for locally sourced alternatives with improved nutritional value compared to wheat in the production of various food products. OFSP is a biofortified variety of sweet potato, bred for high provitamin A carotenoid content which makes it a suitable choice for food based intervention program to address vitamin A deficiency in many developing countries (Kurabachew, 2015). Early maturing OFSP varieties are adaptable to changing climatic conditions because they produce within short time (3–4 months) and a broad temperature range. They can grow on marginal soils, and as a rotation crop thereby helping in the management of pest and disease incidence (Low et al., 2017). However, the protein content of OFSP is low and deficient in sulphur containing amino acids such as lysine and leucine (Ravindran et al., 1995). This necessitates the need for supplementation of OFSP with protein rich crops such as the sclerotium of Pleurotus tuberregium.

Pleurotus tuberregium is an edible mushroom which often forms an edible underground tuber called sclerotium. The sclerotium of Pleurotus tuberregium contains a good amount of protein (17.6%) (Arubi, 2010), and it is also a rich source of minerals, vitamins and phytochemicals (Ikewuchi and Ikewuchi, 2009; 2011; Oranusi et al., 2014). Various studies have been reported towards the reduction of wheat importation and enhancing the nutritional value of wheat to combat malnutrition through partial substitution with locally available crops (Bibiana et al., 2014; Oyeyinka et al., 2014; Ekunseitan et al., 2016). However, no study has been reported on the production, chemical composition, functional and pasting properties of OFSP and Pleurotus tuberregium sclerotium flour blends. Therefore, this study was designed to determine the chemical (proximate and sugar) composition, functional and pasting properties of flour blends produced from Orange-Fleshed Sweet Potato (OFSP) and Pleurotus tuberregium sclerotium.

2. MATERIALS AND METHODS

Samples collection

Wheat flour was purchased from a shopping mall (Giant) in Serdang, Selangor, Malaysia. Orange-Fleshed Sweet Potato (OFSP) tubers were harvested from an experimental farm located at Agricultural Research Management Training Centre (ARMTI), Ilorin, Kwara State, while *Pleurotus tuberregium* sclerotium was obtained from Aleshinloye market in Ibadan, Oyo state, Nigeria. The chemicals, reagents and solvents used were purchased from Merck Sdn. Bhd., Malaysia and were of analytical grade.

Preparation of OFSP and *Pleurotus tuberregium* sclerotium flour blends

The fresh OFSP tubers were washed and trimmed to remove dirt and soil. They were peeled, washed and sliced thinly to a 2 mm thickness with a fabricated slicer (Berkel, by ASEAN Australia Economic Cooperation Project). OFSP slices were dried using a cabinet dryer at 60^{o}C for 8 hours and then allowed to cool. The dried slices were coarse-milled with laboratory food processor (Panasonic, Malaysia) and later milled to flour (150 μm) with laboratory grinder (Panasonic, Malaysia). The milled OFSP flour was vacuum sealed in a non-transparent plastic. Sclerotium root was cleaned, grated and milled into fine powder after drying at 40^{o}C for 6 hour. Flour blends were produced by mixing OFSP and sclerotium flours in various proportions as shown in Table 1. The flour samples were stored in a chiller (-4^{o}C) for further analyses. Prior to drying, samples were obtained from the fresh slices of OFSP tubers (F) and sclerotium roots (FS) for analyses.

Table 1 Flour blends and their proportions

Sample Codes	Proportions
S	100% sclerotium flour
Y	100% OFSP flour
YS_1	90:10 OFSP/sclerotium flour
YS_2	80:20 OFSP/sclerotium flour
YS_3	70:30 OFSP/sclerotium flour

Proximate analysis of fresh and flour samples

The proximate compositions of the fresh OFSP, sclerotium root and their flour samples were determined using the standard methods of **AOAC (2005)**. The samples were analyzed for moisture, protein, ash, fat, crude fibre and carbohydrate was determined by difference.

Sugars determination

The HPLC method as described by **Hunt *et al.* (1977)** with slight modification was used to determine the sugars in fresh and flour samples. About 10 g of ground sample was heated with 100 mL of methanol in steam water bath for 30 min at 80 ^{o}C with constant agitation. The mixture was then filtered through Whatman No. 1 filter paper, and the residue was re-extracted twice with 75 mL of methanol and filtered. The filtrate was evaporated using a rotary vacuum evaporator at 50 ^{o}C to concentrate the sample solution to about 10 mL. The evaporated sample was then filtered through a 0.45 μm membrane filter using a syringe and stored in vials for further analysis. The HPLC was equipped with a Waters 410 differential refractometer detector, and a Waters PU-501 HPLC pump. The column used for analysis was 5µm Purospher Star NH_2 column, Lichrocart (250 mm x 4.6 mm), Merck KGaA, Darmstadt, Germany. Degassed 80% acetonitrile (acetonitrile and distilled water v/v) was used as the mobile phase. Ten microliters of the extracted sample was manually injected into the column with a flow rate of 1.0 mL/min. Sugars in the samples were quantified by comparing peak areas of the samples with standards. A glucose, fructose and sucrose standard at concentrations of 0.5, 1.0, 1.5, and 2.0% (w/v) was prepared. A calibration curve was obtained for each of these sugars. Data were analyzed using Borwin PDA software (version 1.5, JASCO CO. Ltd., Japan).

Determination of colour

The colorimetric measurements (Colour L*, a* and b*) of the fresh and flour samples were carried out using a Konica Minolta Colour Sensor (Chroma meter CR-410, Minolta LTD, Japan) as stated by **Ahmed and Hussein (2014)**.

Functional properties of fresh and flour samples

The standard methods described by **AOAC (2005)** were used for the determination of bulk density, water and oil absorption capacities, swelling index and solubility of each sample.

Pasting properties of the flour samples

Pasting parameters (pasting temperature, peak time, peak, trough, breakdown, final and setback viscosities) of the flour samples were determined using a Rapid Visco Analyzer (Newport Scientific Pty Ltd) as described by **Newport Scientific (1998)**. A 2.50 g of flour sample was weighed into a previously dried empty cannister; and 25 ml of distilled water was dispensed into the cannister containing the sample. The suspension was thoroughly mixed and the cannister was fitted into the rapid visco analyzer. Each suspension was kept at 50% for 1 min and then heated up to 95 °C at 12.2 °C/min and held for 2.5 min at 95 °C. It was cooled to 50 °C at 11.8 °C/min and kept for 2 min at 50 °C.

Statistical analysis

All the analyses were performed in triplicates and data obtained were subjected to one-way Analysis of Variance (ANOVA) and expressed as mean $\pm$ standard deviations. Means were separated using Fisher's least significant difference test at 95% confidence level of 5% level of significance. Minitab V. 15 Statistical package (Minitab Inc. Pennsylvania, USA) was used to perform the analysis of results.

3. RESULTS AND DISCUSSION

Proximate composition of fresh OFSP, *P. tuberregium* sclerotium and their flour samples

The proximate composition of the fresh and flour samples is presented in Table 2. The moisture, fat and carbohydrate contents reduced while the protein, ash and crude fibre contents of the composite flour increased with increase in the level of sclerotium flour substitution. The proximate compositions of the fresh samples, except the carbohydrate content of fresh sclerotium tuber, were significantly ($P<0.05$) different from their corresponding flour samples. The general increase in the proximate parameters of the flours compared to their corresponding fresh samples might be attributed to concentration of nutrients due to moisture reduction. The moisture contents of the flour samples ranged from 9.92 for 100% sclerotium flour to 10.55% for 100% wheat flour and they are not significantly different from one another. The low moisture content (< 11%) of the flour samples is favourable for long term storage (**Polycarp *et al*., 2012**). The significant ($P<0.05$) reduction in the moisture content of the fresh samples after drying supported the assertion of **Kolawole *et al*. (2016)** that drying extends the shelf life of foods by suppressing the rate of enzymatic and microbial activities through reduction in water activity. The protein content of the flour samples ranged from 4.58 for 100% OFSP to 18.97% for 100%

sclerotium flour. The sclerotium of *Pleurotus tuberregium* has been reported to be rich in protein (**Ikewuchi and Ikewuchi, 2009**). The high protein content (18.97%) of 100% sclerotium flour justified the significant (P<0.05) increase in the protein contents of composite flours with increase in the level of sclerotium flour substitution. No significant difference (p<0.05) existed between the protein contents of wheat and 30% sclerotium substituted OFSP flours. Dietary protein is necessary in the synthesis of new cell, repair of worn out tissues, hormones production and maintenance of the body system (**Oloyede and Kolawole 2004**). The ash and crude fibre contents of the flours as well as the fat and carbohydrate contents of composite flours were significantly (P<0.05) different. The fat content (1.80%) of wheat flour was observed to be significantly higher than that of fresh and other flour samples. These trends could be attributed to higher ash (5.38%), lower fat (1.07%), higher crude fibre (9.08%) and lower carbohydrate (55.58%) contents of 100% sclerotium flour (Table 2). **Ikewuchi and Ikewuchi (2009)** had also reported that *Pleurotus tuberregium* sclerotium is a rich source of proteins, carbohydrates and fibres.

Sugar composition of fresh OFSP, *P. tuberregium* sclerotium and their flour samples

The sugar content of the flour samples ranged from 0.02 mg/g in wheat flour to 2.18 mg/g in 100% OFSP flour for fructose, 0.02 mg/g in 100% sclerotium flour to 4.53 mg/g in 100% OFSP flour for glucose and 1.04 mg/g in 100% sclerotium flour to 11.29 mg/g in 100% OFSP flour (Table 3). The main sugars in fresh sweet potato samples were sucrose, glucose and fructose, out of which sucrose was observed to be the predominant sugar in fresh and 100% flour samples of OFSP root and sclerotium tuber (Table 3). Similarly, many authors have reported that sucrose is the most abundant sugar in raw sweet potatoes with lower quantity of glucose and fructose (**Bouwkamp 1985; Truong *et al.* 1986; Dincer *et al.* 2011; Fetuga *et al.*, 2014**). **Truong *et al.* (1986)** and **Dincer *et al.* (2011)** also stated that the sucrose concentration of raw sweet potato varied with cultivar. Drying caused a general increase in the fructose, glucose and sucrose contents of the fresh OFSP root and sclerotium tuber, though, only those of OFSP root were significant (p<0.05). This is similar to the findings of **Jangchud *et al*. (2003)** that cooking dramatically increased the soluble sugars in orange-fleshed and purple-fleshed sweet potatoes, and **Wei *et al*. (2017)** that blanching resulted into an increase in reducing sugar content of four sweet potato cultivars. The lowest glucose and fructose values recorded for 100% sclerotium flour compared to wheat flour agreed with the findings of **Oranusi *et al*. (2014)** that *P. tuberregium* sclerotium contained glucose and maltose in low concentrations.

Table 2 Proximate composition (%) of fresh OFSP, *P tuberregium* sclerotium and their flour blends

Sample	Moisture	Protein	Ash	Fat	Crude Fibre	Carbohydrate
$W_{(control)}$	10.55±0.05^{c}	8.96±0.13^{c}	1.10±0.08^{h}	1.80±0.10^{a}	1.03±0.07^{g}	76.56±1.14^{ab}
YS_1	10.15±0.04^{c}	6.26±0.09^{e}	2.54±0.03^{e}	1.32±0.09^{bc}	2.09±0.04^{e}	77.64±1.03^{ab}
YS_2	10.12±0.35^{c}	7.44±0.06^{d}	3.18±0.06^{d}	1.28±0.10^{c}	3.05±0.07^{d}	74.93±0.84^{bc}
YS_3	10.08±0.07^{c}	8.90±0.13^{c}	3.66±0.07^{c}	1.20 ±0.20^{d}	3.83±0.05^{c}	72.33±3.01^{c}
Y	10.35±0.15^{c}	4.58±0.06^{f}	2.18±0.06^{f}	1.43±0.08^{b}	1.52±0.03^{f}	79.94±1.31^{a}
S	9.92±0.91^{c}	18.97±0.66^{a}	5.38±0.21^{a}	1.07±0.08^{d}	9.08±0.03^{a}	55.58±0.54^{d}
F	79.20±3.53^{a}	2.55±0.07^{g}	1.47±0.03^{g}	1.07±0.09^{d}	1.01±0.04^{g}	14.70±0.38^{e}
FS	18.32±0.69^{b}	15.70±0.42^{b}	4.93±0.03^{b}	0.73±0.05^{e}	7.63±0.03^{b}	52.69±0.53^{d}

Mean values with different letters in each column are significantly (p<0.05) different from one another.
Where W = 100% Wheat flour, YS_1 = 90% OFSP flour + 10% Sclerotium flour, YS_2 = 80% OFSP flour + 20% Sclerotium flour, YS_3 = 70% OFSP flour + 30% Sclerotium flour, Y = 100% OFSP flour, S = 100% Sclerotium flour, F = Fresh OFSP root, FS = Fresh Sclerotium tuber.

Table 3 Sugar contents (mg/g) of fresh OFSP, *P. tuberregium* sclerotium and their flour blends

Samples	Fructose	Glucose	Sucrose
$W_{(control)}$	0.02±0.02[e]	0.06±0.01[d]	1.96±0.38[e]
YS_1	1.95±0.07[b]	4.20±0.18[a]	9.35±0.38[b]
YS_2	1.77±0.04[c]	3.70±0.04[b]	8.96±0.17[b]
YS_3	1.67 ±0.04[c]	3.10±0.21[c]	7.58±0.13[c]
Y	2.18±0.05[a]	4.53±0.14[a]	11.29±0.50[a]
S	0.12±0.04[e]	0.02±0.01[d]	1.04±0.50[f]
F	1.02±0.03[d]	2.91±0.12[c]	6.61±0.27[d]
FS	0.04±0.02[e]	0.01±0.00[d]	0.99±0.10[f]

Mean values with different letters in each column are significantly ($p<0.05$) different from one another.
Where W = 100% Wheat flour, YS_1 = 90% OFSP flour + 10% Sclerotium flour, YS_2 = 80% OFSP flour + 20% Sclerotium flour, YS_3 = 70% OFSP flour + 30% Sclerotium flour, Y = 100% OFSP flour, S = 100% Sclerotium flour, F = Fresh OFSP root, FS = Fresh Sclerotium tuber.

Table 4 Colour characteristics of fresh OFSP, *P. tuberregium* sclerotium and their flour blends

Samples	Color L*	Color a*	Color b*
$W_{(control)}$	92.75±0.02[a]	0.42±0.02[g]	8.11±0.18[f]
YS_1	76.06±0.16[d]	23.22±0.19[c]	25.51±0.26[c]
YS_2	76.08±0.27[d]	22.60±0.14[d]	24.66±0.33[cd]
YS_3	77.85±0.23[c]	20.71±0.25[e]	23.08±0.36[d]
Y	72.59±0.11[e]	26.44±0.05[b]	27.67±0.67[b]
S	90.69±0.44[b]	1.19±0.08[f]	9.88±0.69[e]
F	58.84±0.00[f]	29.76±0.12[a]	29.73±0.62[a]
FS	91.92±1.14[ab]	1.36±0.03[f]	10.21±1.15[e]

Mean values with different letters in each column are significantly ($p<0.05$) different from one another.
Where W = 100% Wheat flour, YS_1 = 90% OFSP flour + 10% Sclerotium flour, YS_2 = 80% OFSP flour + 20% Sclerotium flour, YS_3 = 70% OFSP flour + 30% Sclerotium flour, Y = 100% OFSP flour, S = 100% Sclerotium flour, F = Fresh OFSP root, FS = Fresh Sclerotium tuber.

Colour characteristics of fresh OFSP, *P. tuberregium* Sclerotium and their flour samples

The results obtained for the CIELAB coordinates (L*, a*, b*) of the fresh OFSP, sclerotium and their flour blends are presented in Table 4. The parameter L* indicated the sample lightness while positive a* and b* values obtained indicated redness and yellowness respectively (**Granato and Masson, 2010**). With the exception of L* value of fresh OFSP root which surprisingly increased significantly ($p<0.05$), drying was observed to reduce the L*, a* and b* values of OFSP and sclerotium samples. This indicated that heat treatment could result into colour changes probably due to alteration in food quality. **Lozano and Ibarz (1997)** have reported that the severity of heat treatment and the resulting quality deterioration of food products could be predicted based on the colour. No significant difference was observed in the L*, a* and b* values of fresh sclerotium and its corresponding 100% flour. The L* values of the composite flours which increased with increase in the level of sclerotium flour substitution were observed to be significantly ($p<0.05$) lower than the value (92.75) recorded for wheat flour while their a* and b* values which decreased with increase in the level of sclerotium flour substitution were significantly ($p<0.05$) higher than that of wheat flour. The high redness (a*) and yellowness (b*) values obtained for OFSP and its flour blends could be attributed to the presence of carotenoid pigments especially β-carotene in OFSP. However, it has been shown that higher L* and lower a* values are desirable in dried food products such as flour (**Doymaz *et al.*, 2006**).

Functional properties of fresh OFSP, *P. tuberregium* sclerotium and their flour samples

The functional properties of food substances which depend on the quality attributes of their macromolecules such as protein, starch, carbohydrate, sugars, fibre and fat, influence their utilization and industrial applications (**Prinyawiwatkul et al., 1997; Fetuga et al., 2014**). The functional properties of the fresh OFSP, *P. tuberregium* sclerotium and their flour blends are shown in Table 5. It was observed that drying significantly ($p<0.05$) increased the functional properties, except the bulk density, of OFSP and sclerotium. This increment could be due to total or partial gelatinization of the flours (**Falade and Olugbuyi, 2010**) as well as the alteration in chemical composition especially protein, fat and starch of the flours during drying. This is plausible because **Prinyawiwatkul *et al.* (1997)** and **Fetuga *et al*. (2014)** have reported that the functional properties of food materials were influenced by their chemical properties. The bulk density of the flours ranged from 0.29 g/ml for 100% sclerotium flour to 0.60 g/ml for wheat flour. With the exception of bulk density, the functional properties of the composite flour were significantly ($p<0.05$) higher than that of wheat flour. The lower bulk density of the composite flour could be attributed to low bulk density (0.52 g/ml) and lowest bulk density (0.29 g/ml) recorded for 100% OFSP and 100% sclerotium flours respectively. The variation in the bulk density of the samples could be attributed to the differences in the individual particle mass, property, size, geometry and density (**Kolawole *et al*. 2016**). Bulk density is an important parameter to be considered in raw materials handling and in choosing and design of packaging materials (**Oyeyinka *et al*., 2014**). However, high bulk density could be desirable from the economic point of view of the packaging requirements. The water capacity of the flours ranged from 0.32–0.50 ml/g for wheat and 100% sclerotium flours respectively. Although the significantly ($p<0.05$) higher protein content of the 100% sclerotium flour could be held responsible for its high water absorption capacity, the differences in the water absorption capacity of the flours could also be attributed to other factors such as the quantity of damaged and undamaged starch and variation in particle size of the flours. This is plausible following the reports of **Afoakwa (1996)**, **Guy (2012)** and **Oyeyinka *et al*. (2014)** that water absorption capacity could be influenced by the hydrophilic food constituents. Oil absorption capacity of the flours ranged between 0.27 ml/g for wheat flour and 0.53 ml/g for 100% sclerotium flour. The high protein content of 100% sclerotium flour could be responsible for its oil absorption capacity. Similar relationship had been suggested by **Oyeyinka *et al*. (2014)** and **Ekunseitan *et al*. (2016)**. **Wan and Kinsella (1991)** also attributed the mechanism of oil absorption to interaction between fat and non-polar chain of protein as well as the physical entrapment of oil. However, the low water absorption capacity of wheat flour in this study could be an indication that particle size also influences oil absorption capacity of food materials. Oil absorption capacity is important as it could influence the acceptability and storage stability of food products (**Seena and Sridhar, 2005**). It was also observed that the oil and water absorption capacities of the samples increased as the bulk density decreased. The swelling index of the flours ranged from 4.52–7.19 while the solubility ranged between 14.97 and 28.82 % for 100% sclerotium and 100% OFSP flours respectively. A direct relationship was observed between the swelling index and solubility of all the samples; as the swelling index increased, the solubility also increased. Although the functional properties of the composite flour varied with the levels of sclerotium flour substitution, only the solubility of the flour was observed to be significantly (p<0.05) different. However, the differences in swelling index of the samples could be attributed to variation in starch content and presence of other components such as lipids and proteins (**Priyawiwatkul *et al*., 1997**). Solubility reflects the degree of dissolution during the starch swelling procedure. The high solubility value recorded for OFSP flour could be due to its higher soluble sugar content (Table 3).

Pasting characteristics of OFSP flour, *P. tuberregium* sclerotium flour and their flour blends

The digestibility, texture, appearance and utilization of starch-based food materials are influenced to a large extent by their pasting properties (**Ajanaku *et al*., 2012; Onweluzo and Nnamuchi, 2009**). The pasting properties of the flour samples are shown in Table 6. The results showed that the pasting temperature and the peak time of the flours ranged from 81.62–86.70 °C and 4.90–7.90 minutes for 100% OFSP and 100% sclerotium flours respectively. Pasting temperature is the temperature at which there is a noticeable increase in viscosity due to the swelling of starch granules and it indicates the minimum cooking temperature (**Ikegwu *et al*., 2009; Ekunseitan *et al*., 2016**). The lower pasting temperatures obtained for the flour blends are therefore an indication of lower energy cost, high components stability, lower gelatinization tendency and high swelling properties of the starch granules. Peak time is the time required for cooking to be achieved. Peak, trough and final viscosities of the flours ranged from 101.33–247.00 RVU, 72.62–159.73 RVU and 68.64–279.77 RVU for 100% sclerotium and 100% OFSP flours respectively. Significant differences existed among the peak viscosities of the composite flour with the values decreasing with increase in the level of sclerotium flour substitution. The values obtained for the peak, trough and final viscosities of sclerotium-OFSP flour blends were significantly higher than that of wheat flour. Peak viscosity measures the ability of starch-based foods to swell freely soon after heating before their physical breakdown (**Sanni *et al*., 2006**). It is also associated with starch, its components and degree of starch damage. **Ekunseitan *et al*. (2016)** reported that trough viscosity is the minimum viscosity value in the constant temperature phase of RVA and it indicated the ability of paste to withstand breakdown during cooling. Final viscosity measures the ability of starch to form paste after cooling (**Shimelis *et al*., 2006**). These indicated that the higher peak, trough and final viscosities of the 100% OFSP flour could be due to its high starch content and high degree of starch damage which enabled the starch granules to swell rapidly during heating. However, higher trough and final viscosities implied that 100% OFSP flour paste could not withstand breakdown during cooling and that the paste was less stable after cooling respectively. The breakdown viscosity of the flour samples ranged from 24.64 RVU for 100% sclerotium flour to 99.19 RVU for 10% sclerotium substituted OFSP flour. **Adebowale *et al*. (2005)** had stated that the higher the breakdown viscosity, the lower the ability of the sample to withstand heating and shear stress during cooking. Hence, OFSP and its flour blends were susceptible to heating and shear stress during cooking. The values obtained for setback viscosity of the flour samples ranged from 41.10 RVU for 100% sclerotium flour to 95.25 RVU for wheat flour and they were significantly different from one another. **Ekunseitan *et al*., (2016)** also reported that wheat flour had the highest setback viscosity compared to the eleven wheat-mushroom-high quality cassava composite flours examined. **Sanni *et al*. (2001)** related lower setback viscosity to higher resistance to retrogradation during the cooling of gari. This means the flour blends are less susceptible to retrogradation.

Table 5 Functional properties fresh OFSP, *P. tuberregium* sclerotium and their flour blends

Samples	Bulk Density (g/ml)	WAC (ml/g)	OAC (ml/g)	Swelling Index	Solubility (%)
$W_{(control)}$	0.60±0.02^{b}	0.32±0.04^{bc}	0.27±0.03^{d}	4.75±0.11^{c}	19.09±0.22^{e}
YS_1	0.45±0.03^{d}	0.46±0.03^{a}	0.41±0.03^{bc}	7.00±0.11 ^{a}	25.80±0.30^{b}
YS_2	0.39±0.02^{de}	0.47±0.02^{a}	0.43±0.03^{bc}	6.09±0.15^{b}	24.43±0.49^{c}
YS_3	0.34±0.0.01^{ef}	0.48±0.04^{a}	0.47±0.02^{ab}	5.82±0.27^{b}	22.18±0.17^{d}
Y	0.52±0.02^{c}	0.44±0.01^{a}	0.39±0.04^{c}	7.19±0.16^{a}	28.82±0.24^{a}
S	0.29±0.03^{f}	0.50±0.03^{a}	0.53±0.03^{a}	4.52±0.10^{cd}	14.97±0.11^{f}
F	0.82±0.03^{a}	0.26±0.02^{c}	0.22±0.02^{d}	4.33±0.10^{de}	8.89±0.12^{g}
FS	0.45±0.01^{d}	0.36±0.03^{b}	0.36±0.01^{c}	3.96±0.07^{e}	3.96±0.07^{h}

Mean values with different letters in each column are significantly (p<0.05) different from one another.
Where W = 100% Wheat flour, YS_1 = 90% OFSP flour + 10% Sclerotium flour, YS_2 = 80% OFSP flour + 20% Sclerotium flour, YS_3 = 70% OFSP flour + 30% Sclerotium flour, Y = 100% OFSP flour, S = 100% Sclerotium flour, F = Fresh OFSP root, FS = Fresh Sclerotium tuber.

Table 6 Pasting Properties of OFSP flour, *P. tuberregium* sclerotium flour and their flour blends

Samples	Pasting temperature (°C)	peak time (Min)	Peak viscosity (RVU)	Through viscosity (RVU)	Breakdown viscosity (RVU)	Final viscosity (RVU)	Setback viscosity (RVU)
$W_{(control)}$	85.30±0.38^{ab}	5.80±0.50^{bc}	146.50±0.82^{d}	118.0±2.0^{d}	39.30±1.06^{c}	111.56±0.65^{d}	95.25±0.73^{a}
YS_1	82.75±0.27^{cd}	5.71±0.46^{bc}	241.0±3.46^{a}	148.91±0.95^{b}	99.19±0.80^{a}	222.32±0.79^{b}	90.22±0.80^{c}
YS_2	83.92±0.81^{bc}	6.12±0.94^{bc}	201.0±3.61^{b}	150.10±3.17^{b}	77.44±0.64^{b}	218.17±0.73^{c}	87.63±0.23^{d}
YS_3	83.82±0.79^{bc}	6.80±0.52^{ab}	188.0±2.65^{c}	142.32±1.39^{c}	78.54±2.00^{b}	219.20±0.52	85.88±0.30^{e}
Y	81.62±1.12^{d}	4.90±0.60^{c}	247.0±4.58^{a}	159.73±0.97^{a}	98.90±1.23^{a}	279.77±1.07^{a}	91.80±0.53^{b}
S	86.70±0.23^{a}	7.90±0.60^{a}	101.33±0.95^{e}	72.62±0.99^{e}	24.52±0.91^{d}	68.64±0.70^{e}	41.10±0.44^{f}

Mean values with different letters in each column are significantly (p<0.05) different from one another.
Where W = 100% Wheat flour, YS_1 = 90% OFSP flour + 10% Sclerotium flour, YS_2 = 80% OFSP flour + 20% Sclerotium flour, YS_3 = 70% OFSP flour + 30% Sclerotium flour, Y = 100% OFSP flour, S = 100% Sclerotium flour, F = Fresh OFSP root, FS = Fresh Sclerotium tuber.

4. CONCLUSION

The effect of cabinet drying on the physicochemical properties of OFSP and *P. tuberregium* sclerotium was evaluated in this study. This study showed that nutrient-dense flours with high functionality could be produced by blending orange-fleshed sweet potato and *Pleurotus tuberregium* sclerotium flours. Most of the properties of flour blends compared favourably well with that of wheat flour and they could therefore be explored in the production of various food products such as snacks. The production of value added food products using blends of *P. tuberregium* sclerotium flour and OFSP flour would reduce wheat importation; enhance cultivation and utilization of OFSP and *Pleurotus tuberregium*. The flour blends products could also be used in food-based intervention programme to combat malnutrition especially in developing countries.

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