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Determination of Functional, Rheological and Antioxidant Properties of a Developed Good Quality Composite Wheat-Sologold Sweet Potato Flour for Bakery Products

Olosunde William Adebisi [a*], Paul Tosin [b] and Antia Orua Okon [a]

[a] Department of Agricultural and Food Engineering, Faculty of Engineering,University of Uyo, Uyo, Akwa Ibom State, Nigeria.
[b] Department of Agricultural and Bioresources Engineering, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Sologold sweet potato flour is a nutritious flour that contains valuable antioxidants and functional compounds which is suitable for bakery production. The high consumption of baked products prepared wholly from wheat flour can lead to health related challenges such as celiac disease, gluten related allergies, cardiovascular diseases and neurodegenerative disorders. These

**Corresponding author: Email: williamolosunde@uniuyo.edu.ng;*

anomalies can be prevented through the incorporation of sologold sweet potato flour with high antimicrobial and anti-inflammatory properties into the wheat flour for the production of such baked products. Therefore, it is essential to determine best blend flour quality. The objective of this study is to evaluate the functional, rheological and antioxidant properties of a developed composite wheat-sologold flour for bakery products. Complete randomized design (CRD) was employed and the composite flour properties were determined using the Association of official analytical chemist methods. The result of this study shows that sample B3 is the best blend composite. However, sample A1 had no phenolic and anthocyanin contents while sample A2 had the highest total phenolic (42.4), anthocyanin content (48.5) and reducing power (65.8gFe/gfw) while B1 exhibited the lowest reducing power (18.2gFe/gfw). The optimum blend B3 had total phenolic content of 16.5 mgGAE/100gfw, total anthocyanin content of 12.5 mgCyE/100gfw, DPPH 23.8%, FRAP 27.0 mgFe/gfw, peak viscousity 699.1 RVU, bulk density 0.80 g/ml, water absorption capacity 2.20g/g, oil absorption capacity 1.75g/g, peak time 4.4mins and pasting temperature of 799^{o}C.The peak viscosity, final viscosity and set back values showed a significant decrease with the addition of sologold sweet potato flour which resulted in reduction in swelling. Thus, the composite flour optimum blend from sologold sweet potato is a valuable ingredient for developing healthy and functional baked products that promotes health and well-being.

Keywords: Rheological; antioxidants; functional; wheat flour; sologold flour.

1. INTRODUCTION

Composite flour offers significant benefits and advantages for bakery products in terms of improved functional quality, nutritional profile, enhanced properties and economic viability (Awolu *et al*., 2015). This can help to develop healthier, high-quality, and cost-effective products that cater for consumer demands [1]. More so, the utilization of locally available ingredients in composite flour promotes sustainable agriculture and supports local food systems. The benefits of using composite flours in baked products are multifaceted and offers promising opportunities for the bakery industry [2]. Nutritionally rich and health-promoting products have been produced from composite flours sourced from rice, cassava, groundnut, bambara nut, apple, sweet potato, cocoyam and carrot [3-5].Composite flour from sologold sweet potato offers an innovative approach to enhance the antioxidant value and functionality of baked products. Its functional properties make it a promising ingredient for the food industry. Combining different flours can improve the functional properties of the composite flour, such as water absorption capacity, dough elasticity, viscosity, and texture [4]. This can positively impact the handling and processing characteristics of baked products such as bread, biscuits, cake and other pastries [2].

Bakery products containing natural anthocyanins are referred to as healthy foods and may attract health-conscious consumers who value natural and functional ingredients ([6,7]. The incorporation of flour with high total phenolic content which are known for their ability to scavenge free radicals and inhibit oxidative damage, making them more appealing to health-conscious consumers [8]. The total phenolic content is directly related to the antioxidant activity of bakery products. Higher total phenolic content values indicate a greater potential for free radical scavenging, thus enhancing product stability and extending shelf life [9]. Phenolic compounds contribute to the prevention of chronic diseases such as cardiovascular diseases, cancer and neurodegenerative disorders.

Evaluating the antioxidant capacity helps identify ingredients or formulations that can mitigate oxidation and improve product stability [10]. Measuring antioxidant capacity provides valuable insights into the product's potential health benefits and its ability to resist oxidation-related issues, such as rancidity. Functional properties of the composite flour such as wet gluten and water absorption capacity decreased and increased respectively as blending ratio of sweet potato flour increases.

Rheological properties describe the flow and deformation behavior of composite flour-based dough. The rheological properties of wheat flour includes viscosity, elasticity, and viscoelastic behavior which are essential in understanding the flow and deformation characteristics during processing [11]. Rheological properties of wheat flour dough, such as elasticity, viscosity and extensibility are crucial for understanding dough handling properties during mixing, fermentation, and shaping processes. Viscosity indices of interest in this regard are peak, trough, breakdown, final and setback viscosities, pasting and peak time. Peak viscosity refers to the maximum viscosity attained by a starch-based system during baking [6]. It is vital for food and bakery applications as it affects the texture, stability, and mouth feel of the final product [12]. The peak viscosity of flour determines the dough's handling properties, such as elasticity and water absorption.

However, trough viscosity is the minimum viscosity reached after the peak viscosity in a starch-based system [13]. It is relevant in bakery industry applications because it indicates the ability of the starch to retain water and maintain its structure. Breakdown refers to the reduction in viscosity from the peak to the trough in a starch-based system [6]. Understanding breakdown is crucial in the bakery industry as it helps optimize processing conditions to achieve desired textural properties in baked products. Rheological properties showed that flour had breakdown range of 38.33 - 60.76 RVU and setback values of 82.86-173.50 RVU. Final viscosity is the viscosity of a starch-based system at the end of baking or processing. It influences the overall texture, mouth feel, and stability of baked products. The final viscosity helps achieve the desired thickness, smoothness, and clinginess.

Setback refers to the increase in viscosity that occurs after the trough viscosity in a starch-based system upon cooling or during storage [3]. It is relevant in the bakery industry as it influences the stability and consistency of products over time. Setback provides structure and stability to these products, preventing syneresis and maintaining texture during storage and consumption [6,3,14] supported the report that wheat flour had the highest setback viscosity compared to the eleven wheat-mushroom-high quality cassava composite flours examined. Pasting time represents the total time required for starch granules to fully gelatinize and form a stable paste. It influences the baking duration and temperature adjustments needed to achieve desired product characteristics, such as thickness, smoothness and stability. Controlling the peak time ensures the desired texture and consistency of the final products. It provides insights into the gelatinization kinetics and baking time required for starches [15,16]. The objective of this study is to evaluate the functional, rheological and antioxidant properties of a developed composite wheat-sologold flour for bakery products.

2. MATERIALS AND METHODS

2.1 Materials Sourcing and Equipment

The materials used for this study includes wheat flour (Dangote brand) and fresh sologold sweet potatoes, which was collected from National Root Crops Research Institute Umudike, Abia State, Nigeria. The equipment used for this study includes electronic dough mixer, hammer mill, mechanical sieves, electronic weighing balance, electronic PH meter, desiccators, stirrer, volumetric flasks, pipettes, beakers, crucibles, bowls, soxhlet apparatus, digestion flask, rapid visco-analyzer, ultraviolet/infrared and spectrophotometer. The rapid visco analyzer and ultraviolet/infrared spectrophotometer used for this study are shown in Fig. 1 and 2.

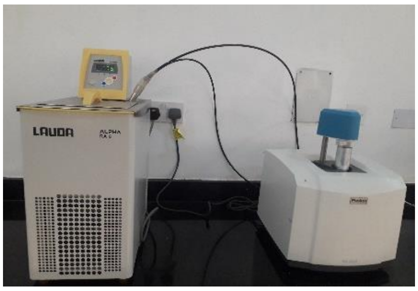

Fig. 1. Rapid visco-analyzer (RVA)

Fig. 2. Ultraviolet/infrared spectrophotometer

2.2 Production of Composite Wheat-Sologold Sweet Potato Flour

The study design used was completely randomized design (CRD) with A1= Wheat flour (100%), SSPF (0%); B1= Wheat flour (90%), SSPF (10%); B2= Wheat flour (80%), SSPF (20%); B3= Wheat flour (70%), SSPF (30%); B4=

Wheat flour (60%), SSPF (40%); B5= Wheat flour (50%), SSPF (50%); B6= Wheat flour (40%), SSPF (60%); B7= Wheat flour (30%), SSPF (70%); B8= Wheat flour (20%), SSPF (80%); B9= Wheat flour (10%), SSPF (90%) and A2= Wheat flour (0%), SSPF (90%) as shown in Table 1.

2.3 Determination of Antioxidant Properties of Wheat-Sologold Sweet Potato Composite Flour

The indices for evaluation of antioxidant properties of the developed composite flour include total phenolic content, total monomeric anthocyanin content and antioxidant capacity.

(a) Determination of total phenolic content of composite flour samples

The total phenolic content was determined by using Folin-Ciocalteu method. Samples extract of 20µL each were respectively mixed with 1.58 mL of water. Then 100µL of Folin-Ciocalteu reagent poured into 1 cm, 2 mL plastic cup and incubated for 5 minutes. Followed by adding 300µL of sodium carbonate solution which was mixed and incubated for 2hours at room temperature (reconstruct the sentence). The sample was observed at 765 nm using a UV-Spectrophotometer (Jenway 7305 Spectrophotometer, USA). Gallic acid was also used as a standard and the results were given as milligram of gallic acid equivalent (mg GAE/100g fw).

(b) Determination of total monomeric anthocyanin content of composite flour samples

The total anthocyanin content was determined using pH differential method. Two sample extracts of 0.3mL were prepared for dilution. 2.7mL potassium chloride buffer was added to a portion of pH 1.0 while (after while add,) 2.7 mL sodium acetate buffer was added to other portion of pH 4.5. The samples were left to equilibrate for 20 minutes before using a UV-Spectrophotometer (Jenway 7305 Spectrophotometer, USA) to determine the absorbance at 510 nm and 700 nm. Difference in absorbance between pH values and wavelengths were calculated using equation 1:

$$A= (A510nm-A700nm)\ pH1.0 - (A510nm-A700nm)\ pH4.5 \quad (1)$$

Concentration of anthocyanin pigment can be calculated as follows:

$$\text{Anthocyanin pigment (mg/L)} = (A \times MW \times DF \times 1000) \div (\varepsilon \times 1) \quad (2)$$

Where:

MW = Molecular weight of Cyanidin-3-glucoside (MW = 449.2)

E = Molar absorptivity (ε = 26900)

DF = Dilution factor (1 is for standard 1 cm path length)

Results were expressed as mg cyanidin-3-glucoside equivalent (mg CyE/100g fw) because it is predominantly found in sweet potato.

(c) Determination of the antioxidant capacity of composite flour samples

Ferric Reducing Antioxidant Power (FRAP) was measured using a method adapted from American Association of Analytical Chemists [17]. Sample extract of 30µL was added into 1mL of FRAP reagent (300 mM acetate buffer of pH 3.6, also with 10 mM TPTZ in 40 mM HCl and 20 mM $FeCl_3$ at a ratio of 10:1:1). The mixture was kept to settle for 5 minutes and the absorbance reading was 595nm using a UV-Visible spectrophotometer (Jenway 7305 Spectrophotometer, USA). Ferrous sulphate ($FeSO_4.7H_2O$) was used as a standard and FRAP was expressed as mg Fe/g fw. The DPPH radical scavenging assay was performed as described by Brand-Willams *et al*. By a slight modification by mixing 0.2 mL of sample extract added with 1.8 mL of methanol and 2 mL DPPH (0.06 mM) in methanol solution. The reaction mixtures were kept at room temperature in the dark for 35 minutes. The absorbance was measured at 517 nm using UV-Spectrophotometer (Jenway 7305 Spectrophotometer, USA). Antioxidant activity (%) by the DPPH free radical was calculated by using the following formula:

$$\text{Antioxidative activity (\%)} = Ab-As\ Ab \times 100 \quad (3)$$

Where,

Ab = Absorbance of blank (DPPH only)
As = Absorbance of sample

Table 1. Wheat-sologold sweet potato flour formulation

Samples	Flour Blend Ratio	SSPF (g)	WF (g)
A1	100% WF, 0% SSPF	0	300
B1	90% WF, 10% SSPF	30	270
B2	80% WF, 20% SSPF	60	240
B3	70% WF, 30% SSPF	90	210
B4	60% WF, 40% SSPF	120	180
B5	50% WF, 50% SSPF	150	150
B6	40% WF, 60% SSPF	180	120
B7	30% WF, 70% SSPF	210	90
B8	20% WF, 80% SSPF	240	60
B9	10% WF, 90% SSPF	270	30
A2	0% WF, 100% SSPF	300	0

SSPF= Orange fleshed sweet potato flour WF= Wheat flour

2.4 Determination of Functional Properties of Wheat-Sologold Sweet Potato Composite Flour

The functional properties of the composite flour were determined using American Association of Analytical Chemists [17] methods. The composite wheat-sologold sweet potato flour blends were obtained by measuring accurately the quantity of wheat and orange flesh sweet potato flours as stated in the experimental runs layout and thoroughly mixed using a blender. The peak, trough, breakdown, final viscosity, setback, peak time and pasting temperature of the composite flour were all determined.

2.5 Determination of the Rheological Properties of Wheat-Sologold Sweet Potato Composite Flour

The rheological properties of the composite flour was determined using the American Association of Analytical Chemists [17] methods. The oil extract, bulk density, water absorption capacity, oil absorption capacity, foam capacity, foam stability and swelling index of the composite flour were all determined.

3. RESULTS AND DISCUSSION

(a) Production of composite wheat-sologold sweet potato flour

The parameters of the developed composite wheat-sologold sweet potato flour to be evaluated includes antioxidants, functional and rheological properties.

(b) Antioxidant Properties of Composite Wheat-Sologold Flour

Antioxidant properties of composite flour consist of total phenolic content and total anthocyanin content coupled with antioxidant capacity evaluation. These factors are important for the functional characteristics of composite flour samples. Table 2 shows the total phenolic and total anthocyanin content of the composite flour samples.

Measuring the total phenolic content allows for the assessment of the overall antioxidant potential of baked products [18]. The result shows that sample A1 had no phenolic and anthocyanin contents (0.0, 0.0) while sample A2 had the highest total phenolic and anthocyanin content (42.4, 48.5) which was higher than all the other samples. The result showed that sologold flour is a good source of antioxidants. Phenolic compounds contribute to sensory qualities such as colour stability, aroma, and taste of food products [19]. Phenolic compounds can delay the oxidation of lipids and other sensitive components in food, thus reducing rancidity and extending the shelf life of products. It can help prevent off-flavors and maintain product freshness [20]. Phenolic compounds exhibit potential health benefits including antioxidant, anti-inflammatory and anticancer properties [21]. Hence, incorporating sologold sweet potato flour (phenolic-rich ingredients) in wheat flour such as the optimum blend which contained 70% (per cent) wheat flour and 30% (per cent) sologold sweet potato flour, to produce bakery products will make healthy and functional diets. The evaluation of antioxidant capacity of the composite wheat-sologold sweet potato flour was carried out based on the ferric reducing power (FRAP) and radical scavenging assay (DPPH). Ferric reducing power (FRAP) indicate the ability of natural antioxidant to donate electrons. Table 3 shows the FRAP and DPPH values of the antioxidant extract of composite flour samples. Sample A2 had the highest reducing power (65.8 g Fe/g fw) while B1 exhibited the lowest power (18.2 g Fe/g fw) among the samples.

There were difference in both FRAP and DPPH values among the flour samples which also shows that the antioxidant capacity of the various samples differ. A study by Acham et al. [7] showed that orange sweet potato demonstrated stronger FRAP and DPPH antioxidant capacity as compared to other commercial food pigments of the anthocyanidin family. The samples antioxidant capacity is dependent on the presence of anthocyanin and phenolic compound in the sologold sweet potatoes used. This observation is supported by other studies which showed that the antioxidant activities of sweet potato does not only come from phenolic and anthocyanin but also from an additive effect with hydroxycinnamic acids [14,20,7]. Blends with high ratio of sologold sweet potato flour (B6, B7, B8 and B9) all showed high antioxidant capacity while blends with lower ratio of sologold sweet potato flour (B1, B2, B3 and B4) showed low antioxidant capacity. Therefore, blends with high ratio of sologold sweet potato flour are recommended with B3 (70% wheat flour, 30% sologold sweet potato flour) as the optimum blend.

(c) Functional Properties of Composite Wheat-Sologold Flour

Fig. 3 shows the functional properties of composite flour samples. These include bulk density (BD), water absorption capacity (WAC), oil absorption capacity (OAC), foam capacity (FC), foam stability (FS) and swelling index (SI).

Bulk density is a measure of the mass of a food material per unit volume. In the bakery industry, bulk density influences the volume and texture of baked products (Kolawole *et al*., 2018). [2] The range of the flour samples bulk density was between 0.82 and 0.70 g/ml with A2 having the highest value and A1 had the lowest. The bulk density of flour affects the measurement of ingredients, dough handling characteristics, final texture of bread and cakes, packaging, transportation of ingredients and finished products [20]. Water absorption capacity refers to the ability of a food material to absorb and hold water. This property is vital in bakery applications such as dough preparation [22]. Torture et al [20]. The range of the flour samples water absorption capacity was between 2.2 and 1.44 g/g with A2 having the highest value and A1 had the lowest. The water absorption capacity of flour affects dough consistency, gluten development, final volume and texture of baked products. It is essential for achieving desired crumb structure and softness [8,9,2].

Table 2. The total phenolic content and total anthocyanin content of wheat and composite flour samples

Sample	Total Phenolic Content (mg GAE/100g fw)	Total Anthocyanin Content (mg CyE/100g fw)
A1	0.0	0.0
B1	06.3±1.5^{a}	03.1±2.0^{a}
B2	11.1±1.2^{ab}	07.4±1.2^{a}
B3	16.5±1.4^{b}	12.5±1.5^{ab}
B4	20.6±1.0^{bc}	15.2±2.0^{ab}
B5	23.2±1.5^{bc}	19.0±1.3^{bc}
B6	27.5±1.2^{c}	24.6±1.0^{bc}
B7	30.6±1.4^{c}	28.4±1.5^{c}
B8	35.0±1.5^{d}	33.0±2.0^{c}
B9	38.2±2.0^{d}	35.2±2.2^{c}
A2	42.4±2.2^{e}	48.5±2.0^{d}

Value followed by same superscript alphabet are not significantly different at (P<0.05) along the column. Values are Mean ± SEM of triplicate determination

Table 3. The antioxidant capacity of wheat-sologold flour samples

Sample	FRAP(mg Fe/g fw)	DPPH (%)
A1	0.0	0.0
B1	18.2±1.0^{a}	14.0±1.0^{a}
B2	23.5±1.5^{ab}	19.5±2.0^{ab}
B3	27.0±1.2^{ab}	23.8±1.0^{ab}
B4	33.4±1.0^{b}	26.0±1.5^{ab}
B5	38.2±1.4^{b}	30.2±2.0^{b}
B6	44.5±2.0^{bc}	35.5±1.0^{bc}
B7	50.6±2.2^{c}	39.2±2.0^{bc}
B8	56.0±2.0^{d}	43.0±2.4^{c}
B9	60.5±1.5^{d}	48.4±2.0^{d}
A2	65.8±3.0^{e}	52.8±2.5^{e}

Value followed by same superscript alphabet are not significantly different at (P<0.05) along the column. Values are Mean ± SEM of triplicate determination

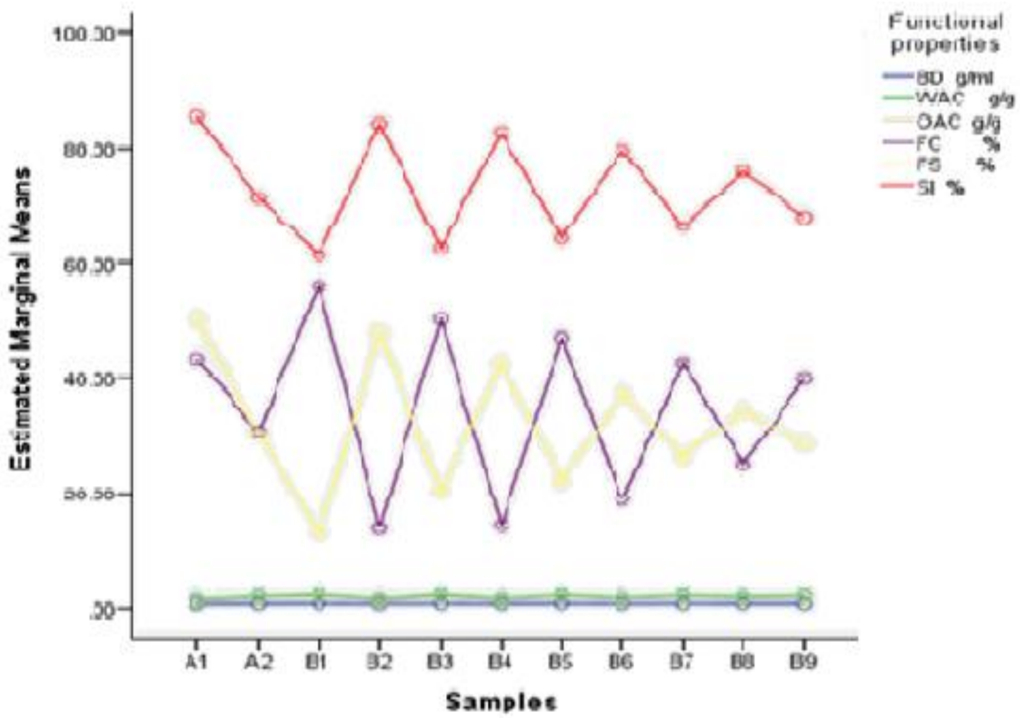

Fig. 3. Functional properties of composite wheat sologold flour blends

Oil absorption capacity refers to the ability of a food material to absorb and retain oil. It is particularly relevant in the production of baked products, where the oil absorption capacity of the coating influences the texture, taste, and oil content of the finished product [18]. The range of the flour samples oil absorption capacity was between 1.78 and 1.13 g/g with A2 having the highest value and A1 had the lowest. Controlling oil absorption capacity helps optimize baking processes and enhance the sensory attributes of baked foods [6,16] Foam capacity refers to the ability of a food material to form and stabilize a foam. The foam capacity of proteins and other foaming agents determines the aeration and stability of these products, affecting their texture, appearance, and mouthfeel [7]. The range of the flour samples foam capacity was between 56.12 and 13.92 % with A2 having the highest value and B2 had the lowest. Understanding and manipulating foam capacity enables the production of light, airy, and visually appealing food products [23,16]. Foam stability measures the ability of a foam to maintain its structure over time. Foam stability is crucial for achieving desirable volume, texture, and mouth feel of bakery and confectionery products (Azni *et al*., 2018).The range of the flour samples foam stability was between 50.07 and 13.06 % with A1 having the highest value and B1 had the lowest. Ensuring good foam stability leads to consistent and visually appealing products [24, 25]. Swelling index quantifies the ability of food materials to absorb water and increase in volume. This property is particularly relevant in the baking industry, where the swelling of ingredients like starches and gums affects the viscosity and texture of dough Awolu et al [3] Awolu et al [4]. The range of the flour samples swelling index was between 85.42 and 61.32 % with A2 having the highest value and B2 had the lowest. Swelling index helps in controlling the hydration and gelatinization properties of ingredients, leading to improved product quality. It affects the texture, viscosity, and functionality of ingredients in bakery products [25].

The analysis of variance for the functional properties of composite wheat-sologold flour is shown in Table 4.

The statistical analysis of variance for average functional properties of the composite flour samples (Table 4) shows that the difference in the bulk density, water absorption capacity and oil absorption capacity of the composite flour samples are not significant (p>0.050) while that of foam capacity, foam stability and swelling index are significant (p≤0.050). Bulk density is generally affected by the particle size and density of the flour. It is very important in determining the packaging requirements, material handling and application in wet processing in the food industry (Singh *et al*., 2005). Blends with high ratio of wheat flour (B1, B2, B3 and B4) showed good properties of swelling index, foam capacity, foam stability, water and oil absorption capacity while blends with high ratio of sologold sweet potato flour (B6, B7, B8 and B9) showed lower functional properties. Therefore, blends with high wheat flour ratio such as the optimum blend B3 (70% wheat flour, 30% sologold sweet potato flour) are recommended.

(d) Rheological Properties of Composite Wheat-Sologold Flour

The rheological characteristics of the different flour samples is shown on Fig. 4

The addition of sologold sweet potato flour (SSPF) decreased the peak and final viscosity values and also influenced the rheological properties (pasting temperature, trough and breakdown) of the composite flour samples. The peak viscosity, final viscosity and set back values showed a significant decrease with the addition of SSPF which resulted from the reduction in swelling and interaction with fibre. The addition of crude fibre from the SSPF significantly decreased the rheological/pasting characteristics. This is in agreement with the results of Kolawole et al, [2] and Obomeghei et al, [1]. The peak viscosities for the composite samples decreased from 754.0 to 290.3RVU. There were significant differences between sample A1, A2 and values obtained from other samples in this study. Peak viscosity indicates the highest value of viscosity attained in a heating cycle by gelatinized starches and it measures the ability of flours to form pastes [20,16,7].

Trough viscosity is a measure of the ability of paste to withstand breakdown during baking [23]. The trough viscosities ranged between 189.5 and 438.3 RVU which shows significant difference among the composite flour samples. The value of trough viscosities increases as SSPF substitution increases. The breakdown viscosities or pasting stability were between 100.8 and 396.0 RVU. Significant differences do not exist among the values obtained. The samples exhibited similar breakdown stability ratios (trough/peak). This implies that the composite flour samples are expected to withstand shear at high temperatures better than the wheat flour sample. Final viscosity is the most commonly used determinant for the quality of a starch based sample. A high final viscosity gives an indication of the ability of the flour to form firm gel. The final viscosities for the composite flour blends ranged between 318.8 and 699.1 RVU. The pasting times ranged between 4.1 and 5.0 minutes. A higher pasting temperature implies higher water-binding capacity and higher gelatinization Adebowale et al. [26]. The pasting temperatures were between 77.6°C and 82.5°C. The ANOVA of the viscosity flow is presented in Table 5. [27].

The statistical analysis of variance for the rheological properties of the flour samples showed that the different values of peak, trough, breakdown, final viscosity and setback of the composite flour samples are significant (p≤0.050) while that of peak time and pasting time are not significant (p>0.050). Composite flour samples with sologold sweet potato flour blends seem to have better pasting properties than that of 100%

wheat flour. Composite flour samples appear to have better viscosity due to the SSPF with higher fiber content which strengthen the flour samples. Functional properties such as peak viscosity, trough viscosity, breakdown, final viscosity, setback, peak time, and pasting time are essential for understanding and controlling the texture, structure and quality of bakery products. Peak values from Fig. 5 to 14 showed that sample A1 (100% wheat flour and 0% SSPF) has lower viscosity to the sample A2 with 0% wheat flour and 100% SSPF and other composite flour samples.

Table 4. ANOVA of the functional properties of composite wheat-sologold flour

Composition		Sum of Squares	Df.	Mean Square	F	Sig.
	Between Groups	12261.94	1	1226.194	0.689	0.99
BD	Within Groups	4	10	.03		
	Total	12265.94	11			
	Between Groups	135.26	1	807.44	1.2506	0.91
WAC	Within Groups	6	10	.06		
	Total	135.37	11			
	Between Groups	149.23	1	1169.714	1.0306	0.92
OAC	Within Groups	6	10	.03		
	Total	149.29	11			
	Between Groups	11694.14	1	1169.714	1.0376	0.030
FC	Within Groups	12	10	.01		
	Total	11708.14	11			
FS	Between Groups	142.96	1	1085.769	3.7607	0.045
	Within Groups	6	10	.02		
	Total	143.02	11			
SI	Between Groups	10857.96	1	1085.276	23.815	0.038
	Within Groups	6	10	.05		
	Total	10858.02	11			

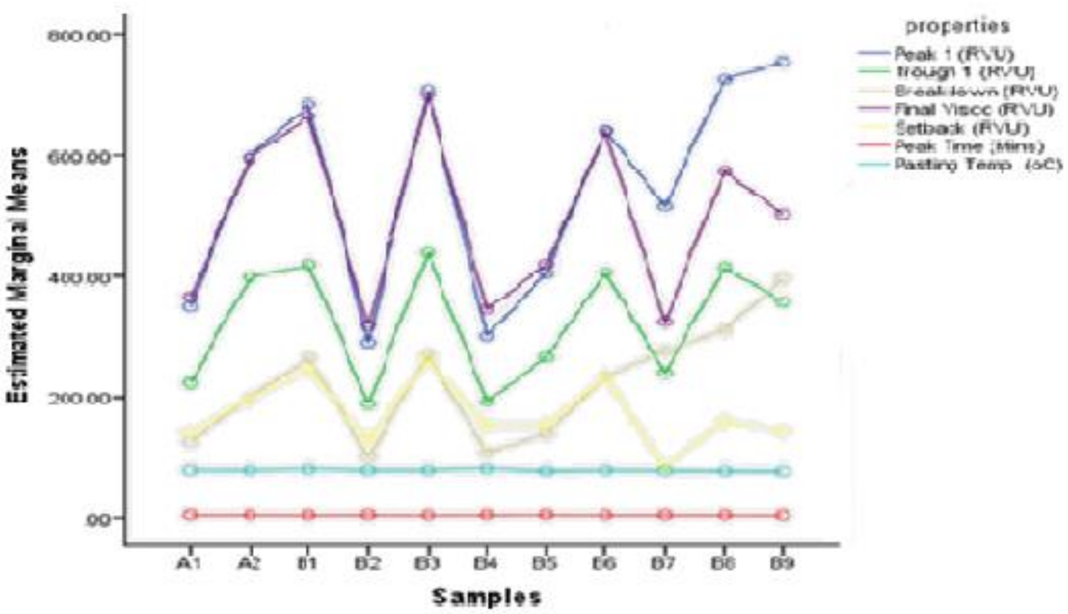

Fig. 4. Rheological properties of composite wheat sologold sweet potato flour blends

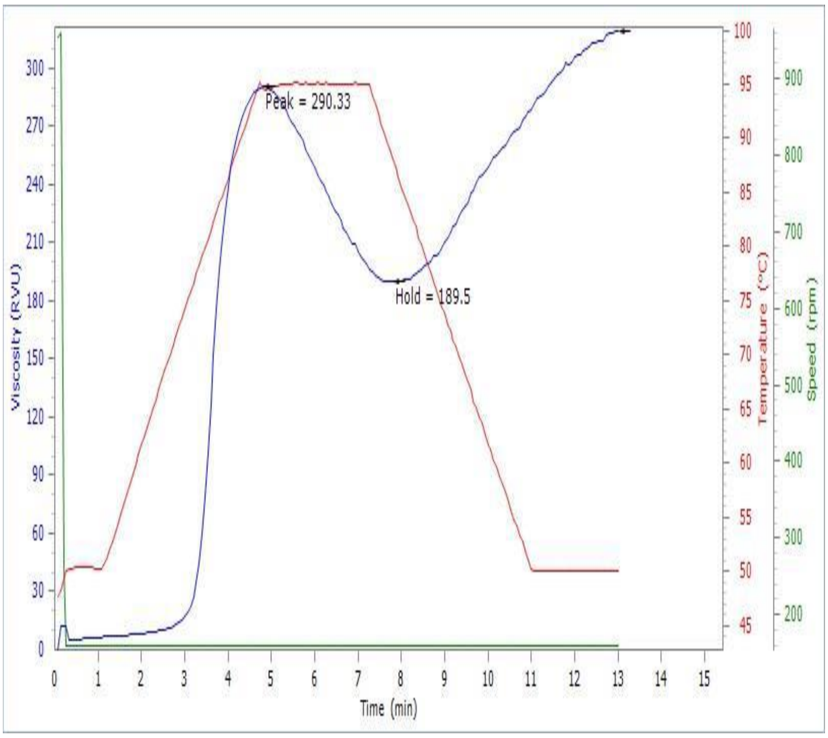

Fig. 5. Viscosity flow curve of sample a1

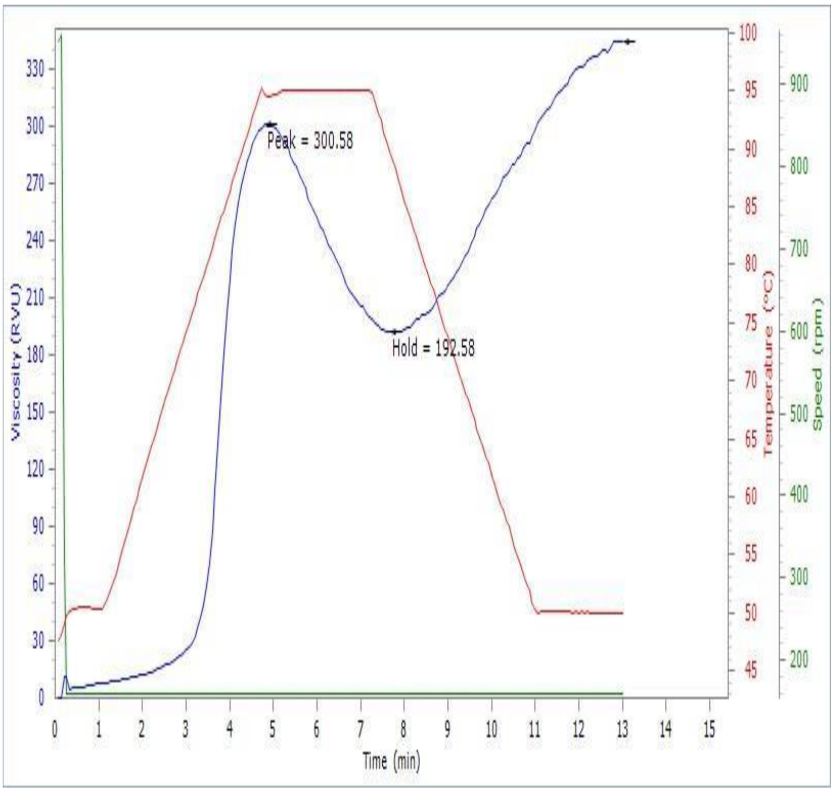

Fig. 6. Viscosity flow curve of sample A2

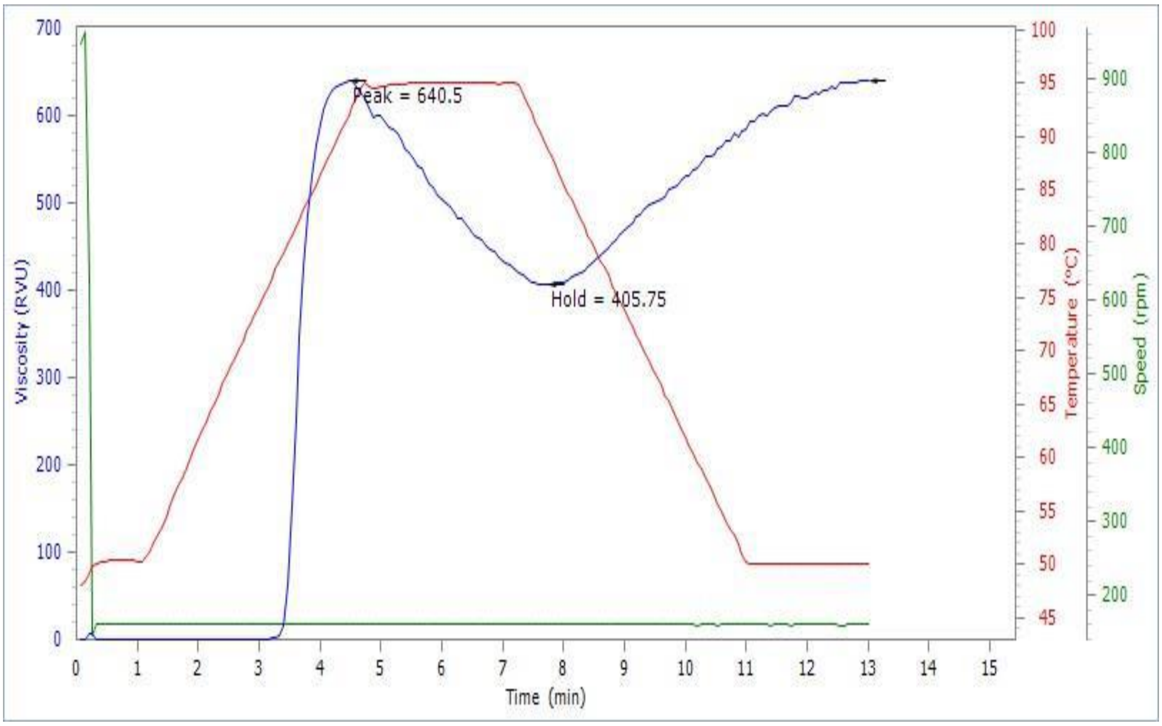

Fig. 7. Viscosity flow curve of sample B1

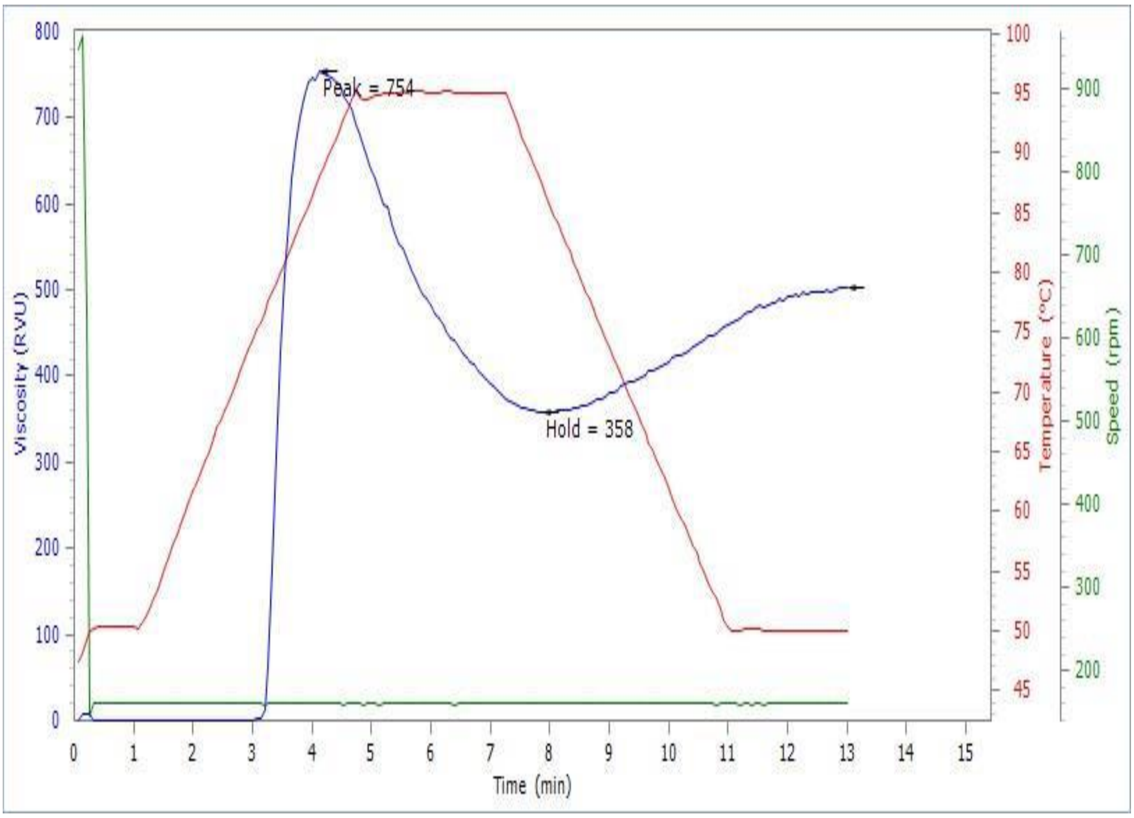

Fig. 8. Viscosity flow curve of sample B2

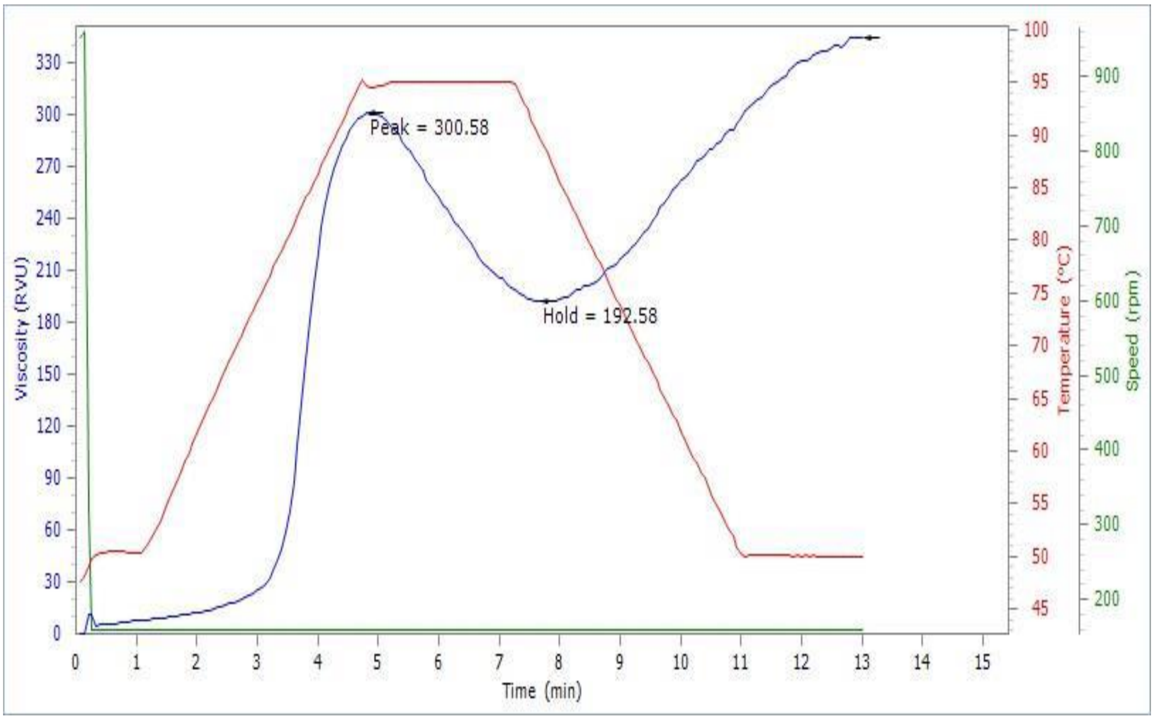

Fig. 9. Viscosity flow curve of sample B3

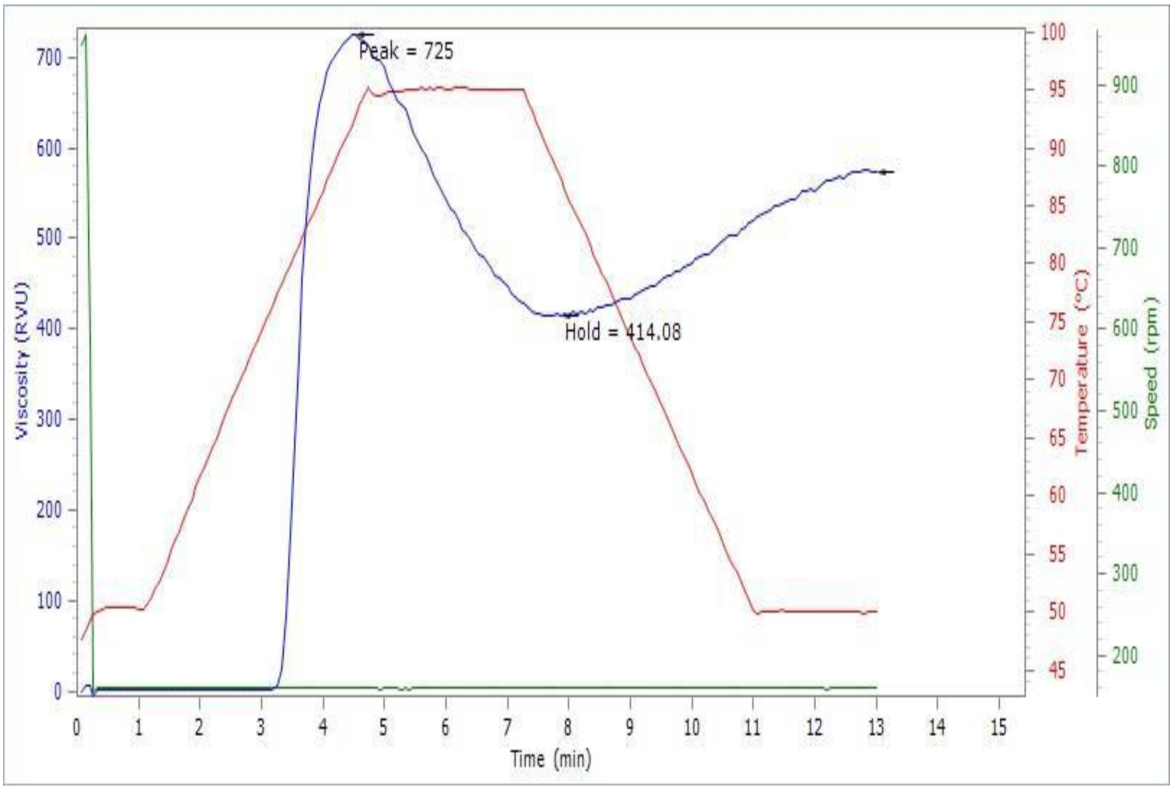

Fig. 10. Viscosity flow curve of sample B4

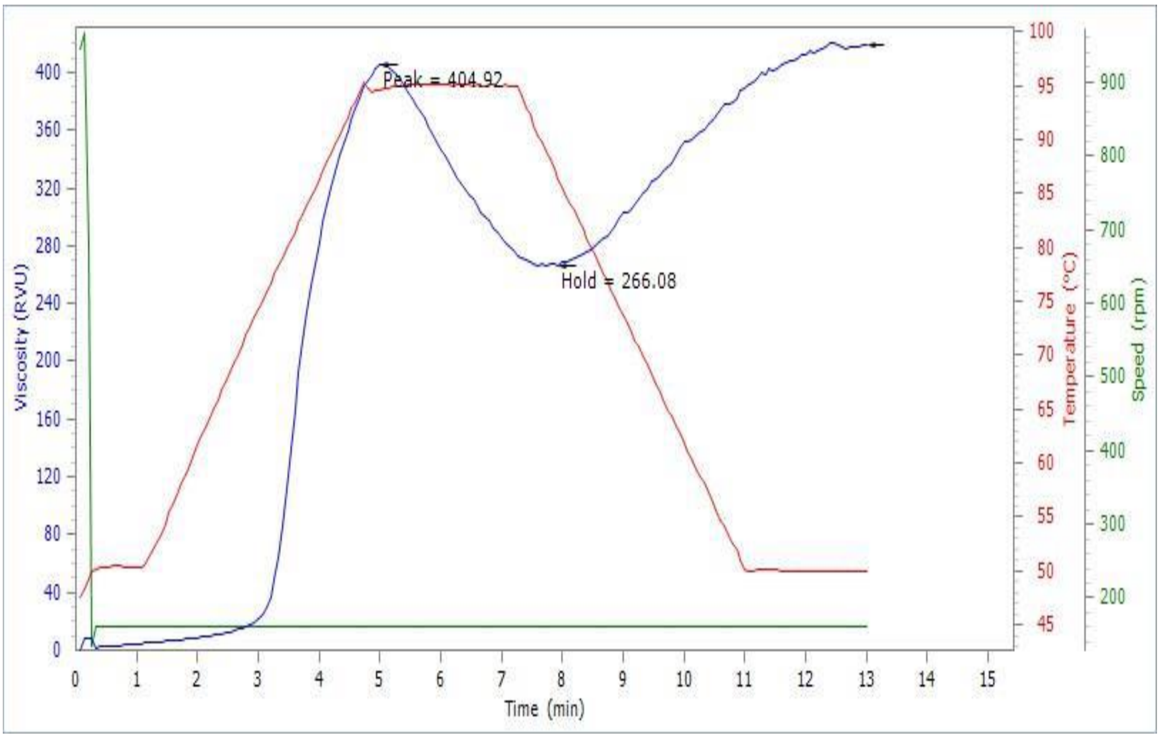

Fig. 11. Viscosity flow curve of sample B5

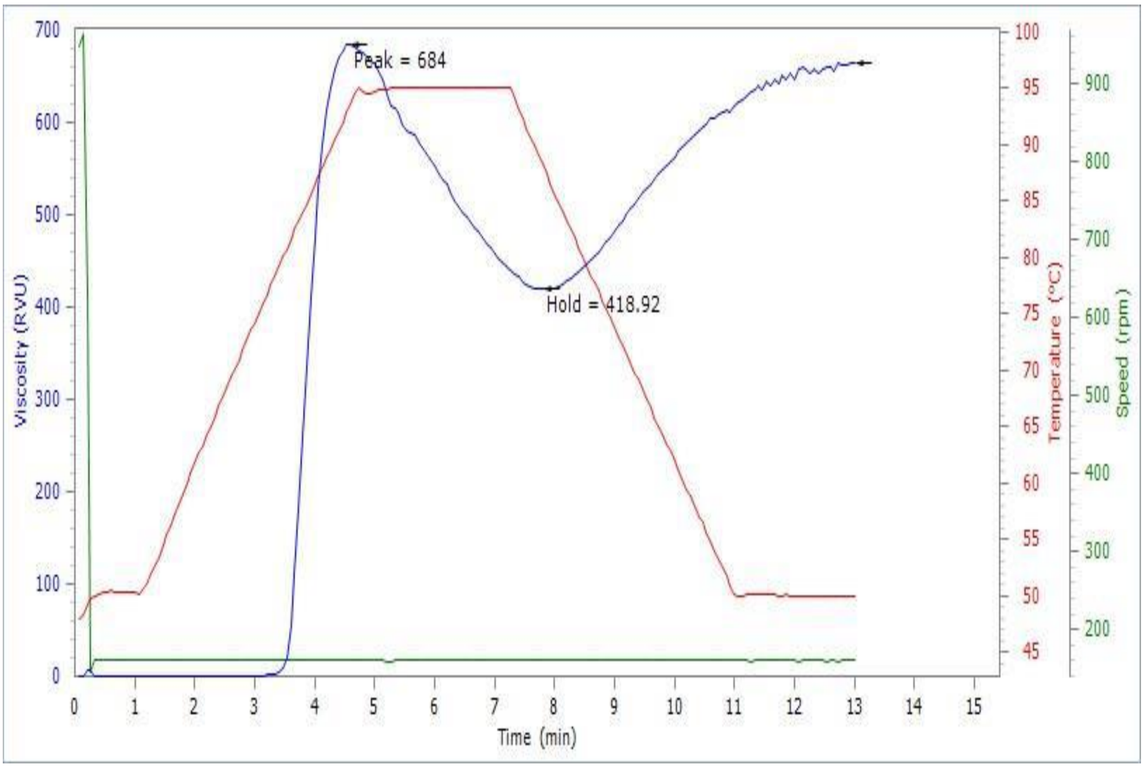

Fig. 12. Viscosity flow curve of sample B6

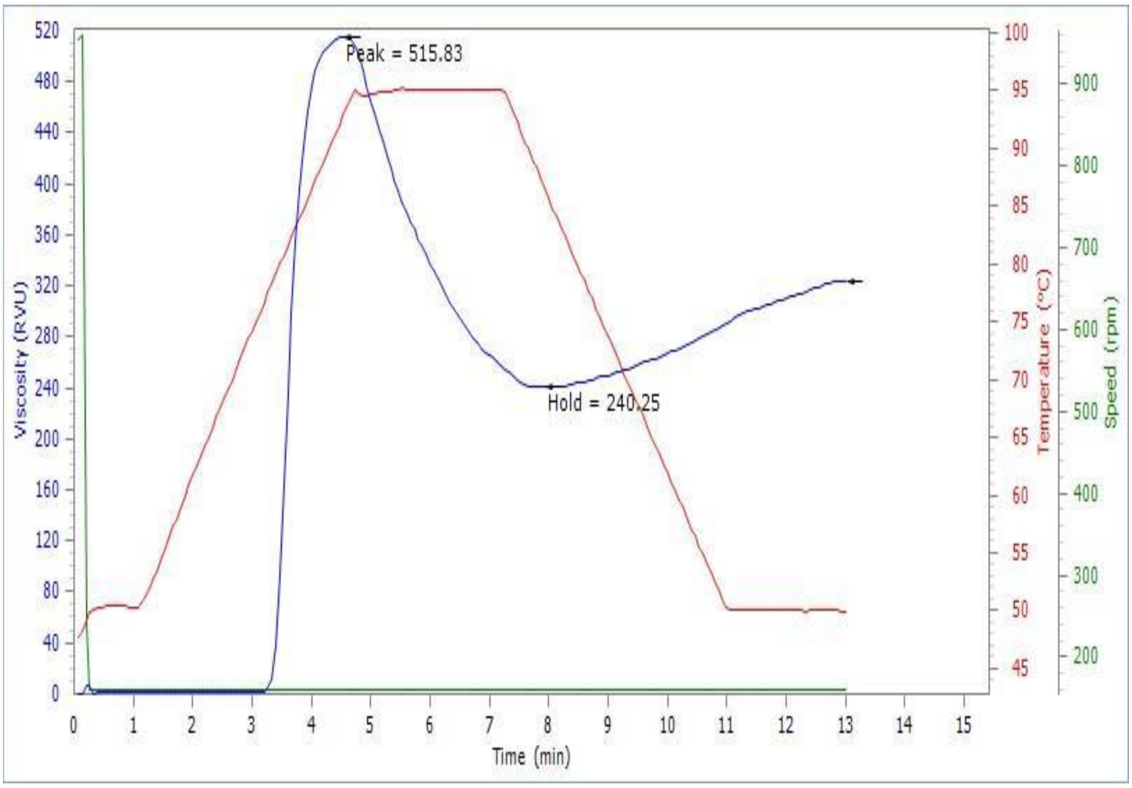

Fig. 13. Viscosity flow curve of sample B7

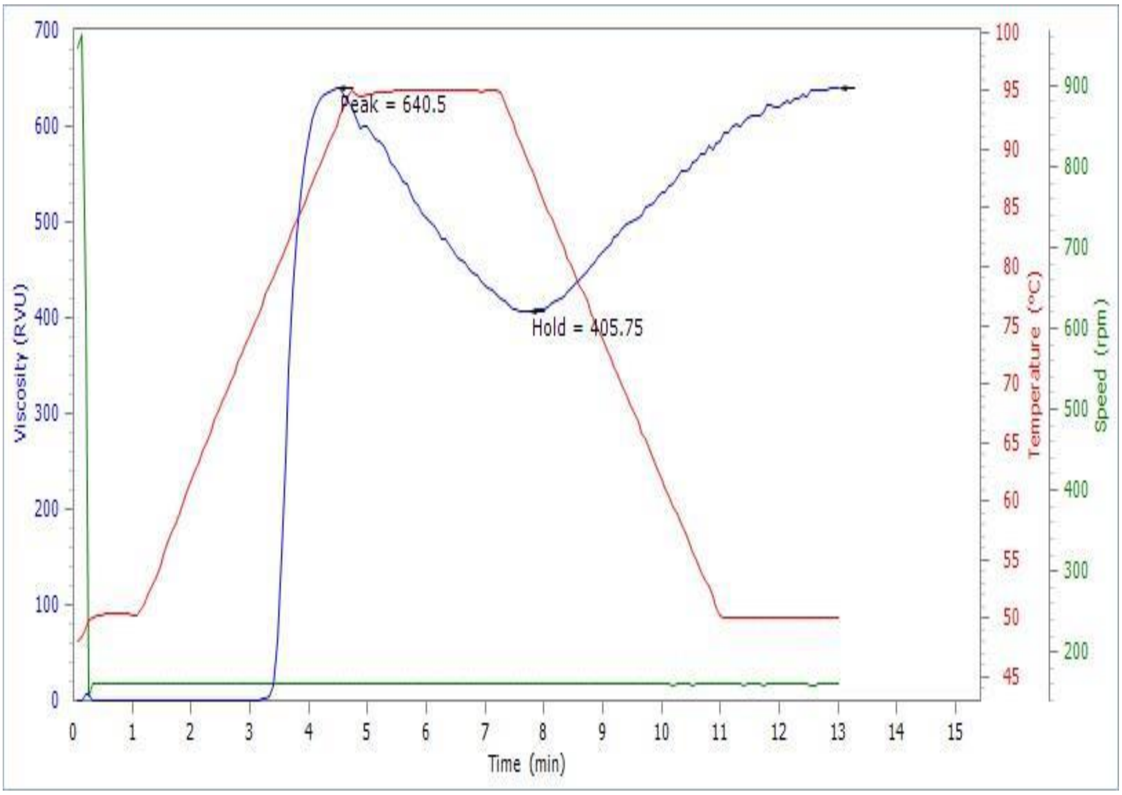

Fig. 14. Viscosity flow curve of sample B8

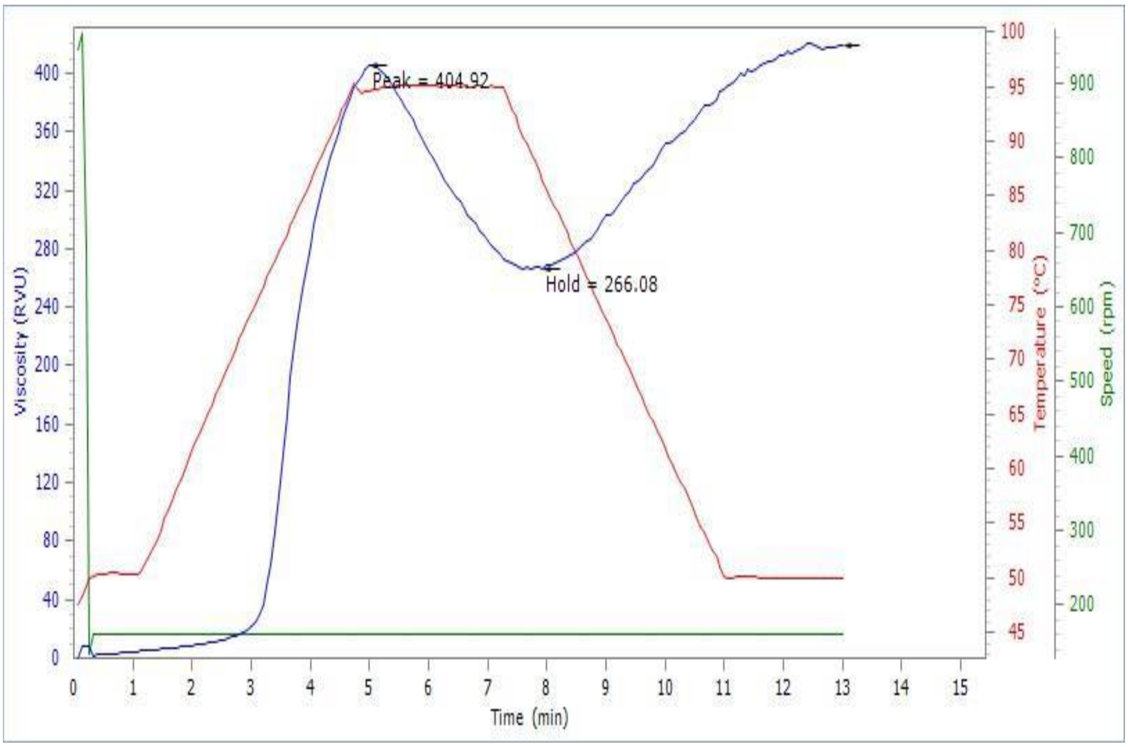

Fig. 15. Viscosity flow curve of sample B9

Table 5. ANOVA of the rheological properties of composite potato flour

Composition		Sum of Squares	Df.	Mean Square	F	Sig.
Peak 1	Between Groups	46.208	24	3.253	9.060	0.0433
	Within Groups	.001	1	.005		
	Total		25			
Trough 1	Between Groups	51.589	22	2.133	12.284	0.0185
	Within Groups	.006	1	.004		
	Total		23			
Breakdown	Between Groups	39.970	24	6.544	3.059	0.0358
	Within Groups	.003	1	.003		
	Total		25			
Final Visco	Between Groups	24.032	23	3.436	4.043	0.0545
	Within Groups	1.03	1			
	Total		24			
Setback	Between Groups	18.314	1	5.562	1.318	0.0411
	Within Groups	0.25	22			
	Total		23			
Peak time	Between Groups	14.467	1	4.946	7.882	0.7302
	Within Groups	.031	24	.001		
	Total		25			
Pasting temp	Between Groups	18.314	1	8.564	6.318	0.4112
	Within Groups	0.15	22			
	Total		23			

Blends B1, B2, and B3 with peak viscosity of 725, 724 and 699.1 respectively are recommended as the best blends with good rheological properties.Thus, the optimum blend B3 (70% wheat flour, 30% sologold sweet potato flour) is recommended.

4. CONCLUSION

The result of this study shows a significant increase in the functional and antioxidant properties with the addition of sologold sweet potato flour in the composite samples while rheological properties showed a significant decrease with the addition of sologold sweet potato flour. The composite flour from sologold sweet potato is a valuable ingredient for developing healthy and functional baked products that promotes health and well-being. The composite sample B3 is the best blend for use in bakery products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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