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Utilization of Tomato Pomace and Orange-Peel Powders with Wheat Flour for the Production of Biscuits

Abstract

This study was carried out to study the effect of substitution of soft wheat flour (SWF) with 3.0, 6.0, 9.0 and 12% of TPP and 5.0, 10.0, 15.0 and 20.0% OPP on rheological, chemical, sensory characteristics, and texture profile of biscuits. Results showed that, farinograph parameters of SWF supplemented with TPP and OPP increment enhanced the water absorption, arrival time, dough development time, dough stability, the mixing tolerance index, and weakening. The biscuits fortified with TPP and OPP contained more fat, ash, and crude fiber compared to control. However, total carbohydrates were decreased in parallel with increasing the level of substitution TPP and OPP compared with control biscuit samples. The experimental biscuits with TPP and OPP were darker in color than the control: the lightness (L*) decreased as the proportion of TPP and OPP increased. However, the experimental biscuits had a higher level of yellowness (b*) and redness values (a*). The partial replacement of SWF with TPP and OPP increased weight and thickness while, specific volume and spread ratio decreased with increasing the level of substitution. Texture profile analysis of biscuits supplemented with different levels of OPP and TPP such as Hardness (N), Fracture Load Drop off (N) and Fracture Work Done (mj) were increased with increasing the level of substitution TPP and OPP compared with control biscuit samples. Greater proportions of TPP and OPP resulted in poor sensory ratings for color, taste, flavour, texture, appearance, and overall acceptability.

Keywords

Tomato Pomace Powder • Orange Peel Powder • Chemical Composition • Rheological Properties • Baking Quality • Color Attributes • Texture Profile • Organoleptic Properties

Research Article

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Abbreviation

OPP: Orange Peel Powder • **TPP:** Tomato Pomace Powder • **CMC:** Carboxy Methyl Cellulose • **RVA:** Rapid Visco Analyzer • **ANOVA:** Analysis of Variance • **LSD:** Least Significant Difference

Introduction

Popular confectionary items, biscuits are typically eaten as a sweet dessert rather than a savory meal. Cookies have a long shelf life and minimal water activity, which makes them useful as emergency food. However, according to Ismail et al [1], biscuits are generally deficient in nutrients like fiber, protein, and minerals. Because of its flavor, crisp texture, ready-to-eat quality, high nutritional content, variety of forms, and reasonable price, biscuits are enjoyed by people of all ages. The essential constituents of biscuits are wheat flour, sugar, oil, water, and salt. As a result, they are unhealthy for regular consumption because they are low in fiber, vitamins, and minerals and high in calories, fat, and carbohydrates. Additionally, biscuits are poor in phytochemicals. TPP and OPP are rich in pigment, dietary fiber, oil and they contain several bioactive compounds such as, flavones, lycopene, pectin, α-tocopherol, and phenolic acids; these compounds also use as a natural antioxidant for biotechnological, pharmaceutical and food industries, which have been linked to positive health effects. Nonetheless, biscuits can be fortified with nutritious elements and bioactive compounds due to their acceptance and extended shelf life [2].

Fruits and vegetables provide a significant number of vitamins, minerals, and fiber in our daily diet, making them vital for human nutrition. Regretfully, half of the fruits and vegetables grown worldwide are wasted, leading to problems for the environment primarily from microbial deterioration. Industrial processing produces the majority of trash, or what are known as by-products. Numerous beneficial substances, including phytochemicals like polyphenols and carotenoids and macronutrients like proteins and carbs, are still present in these byproducts [3]. The product's nutritional value was raised by adding fruit and vegetable by-products. Biscuits with added vegetable and fruit by-products showed better nutritional qualities, including minerals and dietary fiber. High-level inclusion, however, can have an impact on the biscuits' texture and sensory appeal. As an alternative, biscuits might make healthful snacks.

The nutritional and chemical qualities of developed biscuits can be further enhanced by adding tomato pomace powders, mango seed kernel powders, and pomegranate peel powders to bakery products like biscuits, which are highly popular with kids and a rich source of protein and energy [4]. Therefore, the goal of the research was to create a new biscuit formulation using various mixes of tomato pomace powder (TPP) and orange-peel powder (OPP) with soft wheat flour. It also aimed to ascertain how processing methods affected the biscuits' chemistry, rheology, color, backing quality, sensory attributes, and texture profile.

Materials and methods

Materials

1. Tomato pomace (peel and seeds) was obtained from Kaha Company for Preservative Foods Kaha, Kalyobia, Egypt.
2. Orange waste (Citrus sinensis) Balady orange variety: were obtained from Kaha company for canned food, Kaha city, Kaliobia, Egypt.
3. Wheat Flour (72% extraction) was obtained from the North Cairo Flour Mills Company, Egypt.
4. Shortening, fresh eggs, sugar, baking powder, salt (sodium chloride), whole milk and vanilla were purchased from a local market in Dokki, Egypt.
5. Chemicals: all chemicals used in this study for analysis were of analytical grade and were obtained from Al-Gomhouria Chemical Company, Egypt.

Methods

Preparation of tomato pomace (peel and seeds) powder: Tomato processing wastes were collected after juice extraction by cold-break treatments. Tomato residues (pomaces) were dried at 50 °C for 12 h in an air circulating oven, submitted to a milling process, sieved (110 mesh), and maintained in polyethylene bags, and stored at -18 °C until use [5,6]. Preparation of tomato pomace (peel and seeds) powder Tomato pomace was separated manually after drying in air. Then it was dried in air circulated oven at 50˚C for 12 hr., milled to a fine powder, sieved on 110 mesh sieves, and kept in polyethylene bags and stored at - 18˚C until used.

Preparation of orange waste (peel and pulp) powder: Orange waste fibres: the by-products obtained from orange peel and the remaining pulp after juice extraction could be suitable sources of DF by cutting, extraction of juice, peel residue chopping, the material was washed under mild conditions to avoid or minimize losses of some soluble fiber components (such as pectins and pentosans) as well as bioactive components (such as flavonoids, polyphenols and carotenes) [7], then dried at temperatures below 65 ºC for 12 hrs. in an electric oven drier, milled to a fine powder, sieved on 110 mesh sieves, and kept in polyethylene bags and stored at - 18˚C until used. [8].

Preparation of composite flour blends: Different composite flour samples were prepared by partially substituting wheat flour (72% extraction) with 3, 6, 9, and 12 % of tomato pomace powder (TPP) and 5, 10, 15 and 20% orange peel powders (OPP) and kept in polyethylene bags and stored at 4˚C until used.

Rapid Viscoanalyzer (RVA) test: The pasting properties of flour blends were measured by using the Rapid Visco Analyzer (Newport Scientific, Sydney, Australia). All samples (3.5 g at 14% moisture basis) were weighed into aluminum canisters, and the distilled water was used to adjust the total weight to 28 accordance with AACC [9].

Preparation of biscuit: The biscuits were prepared by mixing 100 g wheat flour and their blends containing 5, 10, 15 and 20% OPP and 3, 6, 9 and 12% TPP. Biscuit formula was as follows in (Table 1): 100g flour, 35 g sucrose, 28 g shortening, 0.93 g salt, 1.11 g sodium bicarbonate and 1 g vanilla. Biscuit preparation: Fat and sugar were mixed until fluffy. Whole eggs and milk were added while mixing and then mixed for a total of about 30 min. Vanilla, baking powder and salt were mixed thoroughly and added to the cream mixture where they were all mixed together to form a dough. The dough was rolled and cut into shapes of 5 cm diameter. Baking was carried out at 185ºC for 20 min, in preheated oven (SHEL LAB 1370FX, USA). Biscuit samples were cooled and stored in polyethylene bags until needed.

Analytical methods

Chemical analyses: Moisture, protein, Fat, ash and crude fiber contents of raw materials and biscuits samples were determined according to AACC (2000) [9]. Carbohydrates were calculated by difference as mentioned as follows: Carbohydrates = 100 – (% protein + % fat + % ash + % crude fiber).

Caloric value: The total calories of the samples were calculated according to the as follows: Total calories (Kcal/100 g) = (Fat × 9 Kcal) + (Protein × 4 Kcal) + (Carbohydrate × 4 Kcal) +(crude fiber × 2 Kcal)

Physical characteristics of biscuits: Diameter (mm), thickness (mm), spread ratio, weight (gram), volume (ml) and specific volume (ml/gram) were determined as described in AACC (2000) [9], and the spread ratio of biscuits was calculated according to Youssef *et al* [10] as the following equations: Spread ratio = diameter / thickness.

Soft Wheat Flour (SWF) (g)	100	95	90	85	80	97	94	91	88
Orange peel powder (OPP) (g)	-	5	10	15	20	-	-	-	-
Tomato peel powder (TPP) (g)	-	-	-	-	-	3	6	9	12
Carboxy methyl cellulose (CMC) (g)	-	1	1	1	1	1	1	1	1
Whole fresh milk (ml)	25	25	25	25	25	25	25	25	25
Salt (g)	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Sucrose (g)	35	35	35	35	35	35	35	35	35
Shortening (g)	28	28	28	28	28	28	28	28	28
Egg (g)	30	30	30	30	30	30	30	30	30
Baking powder (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vanilla (g)	1	1	1	1	1	1	1	1	1

Table 1: Formula of Biscuits.

Color determinations: The color values of biscuits samples were measured. Hunter L*, a* and b* parameters were measured with a color difference meter using a spectro- colourimeter (Tristimulus Colour Machine) with the CIE lab color scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode Akubor and Abubakar [11].

Sensory properties of biscuits: The sensory evaluation of the prepared biscuit samples was carried out, according to Linda et al [12], by twenty semi-trained panelists from the Food Technology and Nutrition Institute staff at the National Research Centre, Egypt. Sensory evaluation was done in order to determine consumer acceptability. A numerical hedonic scale ranging from 1 to 20 (where 1 is the most disliked and 20 is the most liked) was used for sensory evaluation.

Texture analysis: The baked biscuit samples were analyzed using a texturometer (Brookfield, CT3-10 kg, USA) with a cylinder probe to determine their texture (TA. AACC36). Hardness, stickiness, resilience, cohesion, springiness, gumminess, and chewiness were measured by texture profile analysis (TPA). Two cycles of measurements were programmed into the analyzer to generate a two-bit texture profile curve. The trigger load was 9.00 N g, and the test speed was 2.5 mm/s. Adegoke et al [13]

Statistical analyses: Standard Deviation (SD) have been done using the software Excel 2010. Statistical analysis was conducted with the Co State program using a one-way analysis of variance (ANOVA). The statistical analysis of the obtained results was done with triplicate [14].

Results and Discussion

Chemical composition of raw materials and total calories: Data in (Table 2) presents the proximate composition of soft wheat flour (SWF), orange peel powder (OPP) and tomato peel powder (TPP). The soft wheat flour had moisture of 11.65% which was higher than the 9.43% for the OPP and 6.09% for TPP. The fat, protein and fiber contents of TPP were higher than those of SWF and OPP. While, OPP had ash of 9.43% which was higher than the 4.58% for the TPP and 0.62% for SWF. However, the carbohydrate content of the tomato peel flour was lower than that of SWF and OPP. Ash is an indicative of the amount of mineral in any food sample. The fat content of TPP was higher (8.30%) than that of OPP (5.6%) and WF (1.45%). These results of the chemical composition of raw materials are in agreement with the previous results proved Sakr et al [15] and Yousif et al [16].

Gross chemical composition of control biscuits and biscuits fortified containing OPP or TPP are presented in (Table 3). The moisture content of biscuit samples was found to range from a maximum of 4.11% in the control sample to a minimum of 3.55% in the 20% OPP and there was a highly significant difference between the control and fortified biscuits. The ash content of biscuits varied from 1.22 to 2.11 %. However, no significant difference was noticed in fat content in the most fortified biscuits compared with control. Fiber contents in biscuits were gradually increased in all samples as the substitution proportion of OPP or TPP increased, which might be related to the initial high carbohydrate contents of the raw materials used in the mixtures the statistical analysis showed a highly significant

Samples	Chemical composition of flour samples						Caloric Value (Kcal/100g)
	Moisture	Ash	Crude Fibre	Protein	Lipids	CHO	
SWF	11.65 ± 0.25	0.62±0.10	0.71±0.09	10.32±0.11	1.45±0.14	86.90± 0.31	403.35
OPP	9.43±0.17	9.43±0.07	10.3±0.32	5.5±0.27	5.6±0.05	69.17±0.56	369.68
TPP	6.09±0.29	4. 58±0.01	28.0±0.37	24.3±0.25	8.3±0.03	34.82±0.85	367.18

Table 2. Proximate Chemical composition (%) of raw materials (on dry weight basis).

Where: SWF: Soft wheat flour; OPP: orange peel powder; TPP: Tomato peel powder; Cho: total carbohydrate

Biscuit	Moisture (%)	Chemical composition of fortified biscuit (% on dry weight basis)				
		Protein	Ash	Fat	Fiber	Cho.
Control (100%SWF)	4.11^{cd}	10.05^{d}	1.22^{f}	19.44^{bcd}	0.42^{h}	68.87^{a}
95% SWF + 5% OPP	4.03^{de}	9.34^{e}	1.36^{e}	20.07^{abcd}	0.70^{g}	68.54^{a}
90% SWF + 10% OPP	3.92^{e}	8.52^{f}	1.48^{d}	20.38^{abc}	0.94^{f}	68.69^{a}
85% SWF + 15% OPP	3.70^{f}	7.69^{g}	1.70^{c}	20.72^{a}	1.26^{e}	68.63^{a}
80% SWF + 20% OPP	3.55^{g}	7.18^{h}	1.94^{b}	21.03^{a}	1.74^{d}	68.12^{a}
97% SWF + 3% TPP	4.16^{bcd}	10.17^{d}	1.29^{ef}	19.10^{d}	1.25^{e}	68.20^{a}
94% SWF + 6% TPP	4.21^{bc}	10.53^{c}	1.47^{d}	19.21^{cd}	2.31^{c}	66.49^{b}
91% SWF + 9% TPP	4.29^{b}	10.79^{b}	1.76^{c}	19.91^{abcd}	3.34^{b}	64.20^{c}
88% SWF + 12% TPP	4.56^{a}	11.26^{a}	2.11^{a}	20.56^{ab}	4.12^{a}	61.96^{d}
LSD at 0.05	0.144	0.223	0.103	1.199	0.103	1.325
F	**	**	**	**	**	**

Table 3. Chemical composition of biscuits fortified with OPP or TPP at different levels

Where: SWF: Soft wheat flour; OPP: orange peel powder; TPP: Tomato peel powder; Cho: total carbohydrate. The averages followed by the same letter do not differ statistically between themselves. ** Significative at a level of 1% of probability (p < .01).

difference in fiber content between the control and the fortified biscuits with TPP and OPP. Carbohydrate contents in biscuits were gradually decreased in all samples as the substitution proportion of OPP or TPP increased, which might be related to the initial low carbohydrate contents of the raw materials used in the mixtures and there reduction in carbohydrate content were not significant. These results are in agreement with those reported by Marin et al [17] and Elgindy [18]. On the other hand, protein content was significantly decreased (P< 0.05) with increasing OPP substitution in biscuits. It was found that minimum protein content was observed in 20% OPP biscuit comparing to control sample. And on that, all biscuits obtained in this study can be labeled as bakery products with high fiber and ash contents if compared to control biscuits.

Physical characteristics of biscuits: Results presented in (Table 4) showed the weight (g), volume (cm^3), specific volume (v/w), diameter (cm), thickness (cm) and spread ratio (%) of biscuit samples prepared by substituting different levels of SWF with OPP and TPP compared to control samples. The diameter of OPP and TPP biscuits decreased slightly with increasing substitution percentage the decrease was no significant. Control samples recorded the highest value in the diameter of 2.73 cm whereas 12% TPP biscuits presented the lowest diameter of 2.19 cm. These results coincide with those of Jamal [19], which indicated a decrease in the diameter rate of the biscuits produced by increasing the percentage of adding orange peel powder. The biscuit spread ratio represents a ratio of diameter to thickness, it is an indicator of biscuit quality; thus, high-quality biscuits should have a high spread ratio (Miller and Hoseney) [20]. From the results, it could be seen that the addition of OPP and TPP increased the spread ratio compared to control biscuit samples. These results are in agreement with Hussein et al [21]. Generally, the addition of OPP and TPP to manufacture of biscuit had no significant difference in spread ratio compared to control sample. While there was a highly significant difference in thickness, specific volume and weight of the resulted biscuit.

Color properties of biscuits: Color is one of the most important sensory attributes that affects directly the consumer preference of bakery products. The color parameters of biscuits samples were evaluated using a Hunter laboratory colorimeter (Table 5). The L* scale ranges from 0 black to 100 white, the a* scale extends from negative value (green hue) to positive value (red hue) and the b scale ranges from negative blue to positive yellow.

Biscuit from	Physical properties of fortified biscuit					
	Weight (g)	Volume (cm3)	Specific volume(cm3/g)	Diameter (cm)	Thickness (cm)	Spread ratio (%)
Control (100%SWF)	3.39^{e}	3.75^{a}	1.11^{a}	2.73^{a}	0.31^{cd}	7.64^{b}
95% SWF + 5% OPP	3.42^{de}	3.69^{ab}	1.08^{a}	2.68^{ab}	0.33^{c}	8.13^{b}
90% SWF + 10% OPP	3.48^{cde}	3.54^{bc}	1.02^{b}	2.62^{ab}	0.34^{bc}	7.70^{b}
85% SWF + 15% OPP	3.51^{bcde}	3.37^{d}	0.96^{c}	2.64^{ab}	0.37^{ab}	7.13^{c}
80% SWF + 20% OPP	3.60^{bc}	3.20^{ef}	0.89^{de}	2.57^{b}	0.38^{a}	6.77^{c}
97% SWF + 3% TPP	3.43^{de}	3.53^{c}	1.03^{b}	2.64^{ab}	0.30^{de}	8.80^{a}
94% SWF + 6% TPP	3.55^{bcd}	3.30^{de}	0.93^{cd}	2.43^{c}	0.29^{de}	8.36^{b}
91% SWF + 9% TPP	3.63^{b}	3.09^{f}	0.86^{e}	2.34^{c}	0.28^{de}	8.36^{b}
88% SWF + 12% TPP	3.77^{a}	2.92^{g}	0.78^{f}	2.19^{d}	0.27^{e}	8.11^{b}
LSD at 0.05	0.14	0.158	0.044	0.126	0.032	0.548
F	**	**	**	**	**	**

Table 4. Physical properties of biscuit

The averages followed by the same letter do not differ statistically between themselves. ** Significative at a level of 1% of probability (p < .01).

Biscuit from	Biscuit color		
	L	A	b
Control (100%SWF)	67.07^{a}	10.55^{b}	30.27^{c}
95% SWF + 5% OPP	65.45^{b}	10.89^{ab}	32.30^{b}
90% SWF + 10% OPP	62.38^{cd}	11.61^{ab}	33.75^{ab}
85% SWF + 15% OPP	60.82^{ef}	11.83^{ab}	34.04^{a}
80% SWF + 20% OPP	58.16^{g}	11.97^{a}	34.92^{a}
97% SWF + 3% TPP	63.47^{c}	11.16^{ab}	29.50^{c}
94% SWF + 6% TPP	61.17^{de}	11.62^{ab}	29.64^{c}
91% SWF + 9% TPP	59.61^{f}	11.94^{ab}	29.81^{c}
88% SWF + 12% TPP	56.98^{g}	12.09^{a}	30.09^{c}
LSD at 0.05	1.364	1.406	1.515
F	**	*	**

Table 5. Color parameters of biscuits supplemented with different levels of OPP and TPP

The averages followed by the same letter do not differ statistically between themselves. ** Significative at a level of 1% of probability (p < .01).

It was observed that a significant decrease (P ≤ 0.05) in biscuits ($L*$) values with the increase in OPP and TPP levels compared to the control samples, indicating that the biscuits made with these flours had a darker color than the control. Also, an increase in (a∗) and (b*) values were observed as the OPP and TPP levels increased. These results are in close agreement with a study by Akubor and Abubakar [11] and Abdel-Naeem et al [22]. No significant difference was noticed between the fortified biscuit with OPP and TPP at any concentrate in the a* value which refers to the color red.

Sensory evaluation of biscuits supplemented with OPP and TPP: Effect of fortification of biscuits with OPP and TPP at different levels on the sensory evaluation (taste, odor, color, texture, appearance and overall acceptability) of wheat flour biscuits is shown in (Table 6). Results showed that the control sample was significantly superior in all the sensory attributes under study. The taste, odor, color, texture, appearance and overall acceptability of control sample and biscuits fortified with 5 to 15% OPP and 3 to 6% TPP were superior (probability level P> 0.05) to biscuits fortified with 20% OPP and 9 to 12% TPP. Biscuits fortified with 10% OPP and 6% TPP had the highest scores of tastes, odor, color, texture, appearance and overall acceptability. It was noted that the characteristics of taste, odor, color, texture, appearance and overall acceptability were all decreased by increasing the percentage of OPP and TPP addition. Biscuits fortified with different levels of OPP and TPP was acceptable. The results of sensory evaluation indicated that 10% OPP and 6% TPP can be successfully used in fortification of wheat flour biscuits. Surface color is an important quality component, which affects the acceptability of baked goods made with wheat de Abreu et al [23]. In general, the Overall-acceptability of control sample, biscuit with 5% OPP and 10% OPP had no significant difference which recorded 98.7, 97.5 and 95.2 %; respectively. While, 12% TPP showed the least value of the Overall-acceptability.

Texture properties of biscuit: Texture profile analysis is concerned with measurement of the mechanical properties of a product. (Table 7) and (Figure 1) showed the effect of preparing biscuit from SWF with OPP and TPP on their texture parameters. Hardness of biscuit (control sample) reached to 27.13 N, while biscuit supplemented with OPP and TPP increased to 89.91 and 91.82 N. This result may be due to biscuit containing OPP and TPP related to higher fat and fiber contents, and are in agreement with Sharma et al [24]. Fracture Load Drop Off, Fracture Work Done and Fraction Deformation of biscuit control sample reached to 3.60 N, 44.00 mj and 0.46 mm while biscuit supplemented

Biscuit from	Sensory-Evaluation of Biscuit					
	Taste	Color	Odor	Texture	Appearance	Overall-Acceptability
Control (100%SWF)	19.60^{a}	19.80^{a}	19.60^{a}	19.80^{a}	19.90^{a}	98.70^{a}
95% SWF + 5% OPP	19.50^{a}	19.30^{a}	19.60^{a}	19.50^{ab}	19.60^{ab}	97.50^{ab}
90% SWF + 10% OPP	19.20^{ab}	18.20^{b}	19.40^{ab}	19.40^{ab}	19.00^{ab}	95.20^{bc}
85% SWF + 15% OPP	19.00^{ab}	17.40^{b}	19.50^{ab}	18.90^{ab}	17.70^{cd}	92.50^{d}
80% SWF + 20% OPP	17.50^{cd}	16.40^{c}	18.70^{bc}	18.90^{ab}	16.70^{de}	88.20^{e}
97% SWF + 3% TPP	18.40^{bc}	19.10^{a}	19.60^{a}	18.50^{bc}	18.80^{b}	94.40^{cd}
94% SWF + 6% TPP	16.80^{d}	17.90^{b}	17.90^{c}	17.50^{c}	18.60^{bc}	88.70^{e}
91% SWF + 9% TPP	15.30^{e}	16.50^{c}	16.60^{d}	15.80^{d}	16.50^{e}	80.70^{f}
88% SWF + 12% TPP	14.50^{e}	15.30^{d}	14.20^{e}	15.00^{d}	15.90^{e}	74.90^{g}
LSD	0.945	0.845	0.883	1.013	1.061	2.63
F	**	**	**	**	**	**

Table 6. Sensory characteristics of biscuits supplemented with different levels of OPP and TPP

The averages followed by the same letter do not differ statistically between themselves. ** Significative at a level of 1% of probability (p < .01).

Biscuit Samples	Hardness (N)	Fracture Load Drop Off (N)	Fracture Work Done (mj)	Fraction Deformation (mm)
Control (100%SWF)	27.13	3.6	44	0.46
95% SWF + 5% OPP	27.23	14.56	71	0.86
90% SWF + 10% OPP	35.56	17.63	103	1.67
85% SWF + 15% OPP	52.47	24.53	117	1.7
80% SWF + 20% OPP	89.91	34.57	133	1.82
97% SWF + 3% TPP	29.61	5.86	29	0.22
94% SWF + 6% TPP	43.39	11.42	44	0.24
91% SWF + 9% TPP	50.96	15.04	58	0.29
88% SWF + 12% TPP	91.82	20.69	66	0.43

Table 7. Texture profile analysis of biscuits supplemented with different levels of OPP and TPP

Samples	Water absorption (%)	Arrival time (min)	Dough development time (min)	Dough stability (min)	Mixing tolerance index (BU)	Weakening (BU)
Control (100%SWF)	61.5	0.75	2	12.5	30	80
95% SWF + 5% OPP	62.5	1	2.5	8.5	40	100
90% SWF + 10% OPP	66.5	1.5	3	7	60	110
85% SWF + 15% OPP	68.5	2.5	3.5	5	70	120
80% SWF + 20% OPP	73	3	4	4.5	80	140
97% SWF + 3% TPP	62	1.5	2.5	9	50	90
94% SWF + 6% TPP	63.5	2	3.5	6	60	120
91% SWF + 9% TPP	64.5	2	3.5	5	70	130
88% SWF + 12% TPP	67	2.5	4	4	80	140

Table 8. Effect of addition OPP and TPP at different level on rheological properties of dough (farinograph parameters)

with OPP and TPP increased to 34.57 and 20.69N; 133.0 and 66.00mj; 1.82 and 0.43mm, respectively. These results are consistent with those Heba et al [25].

Farinograph parameters of blends from SWF, OPP and TPP: The effect of Soft wheat flour (SWF) supplementation with OPP (5, 10, 15 and 20%) and TPP (3, 6, 9 and 12%) on rheological properties of dough (farinograph parameters) is presented in (Table 8) and (Figure 2). The result showed the effect of blending OPP at 5, 10, 15 and 20% and TPP at 3, 6, 9 and 12 % with SWF (72%) on the farinograph parameters, i.e., water absorption, arrival time, dough development time, dough stability and dough weakening. Water absorption of the control (SWF) showed a value of 61.5%. SWF blended with different ratios of OPP and TPP showed a gradual increase in parallel with an additional increase. The arrival time increased with the addition of OPP and TPP. Dough development time, mixing tolerance index, and weakening increased compared to control. The mixing tolerance index, which is inversely proportional to the strength of the dough increased from 30 to 80 BU with the addition of OPP and TPP indicating a decrease in the strength of the bread dough. The increased dough development time and decreased dough stability caused by added fiber were possibly associated with slowed water hydration rate and gluten development due to increased

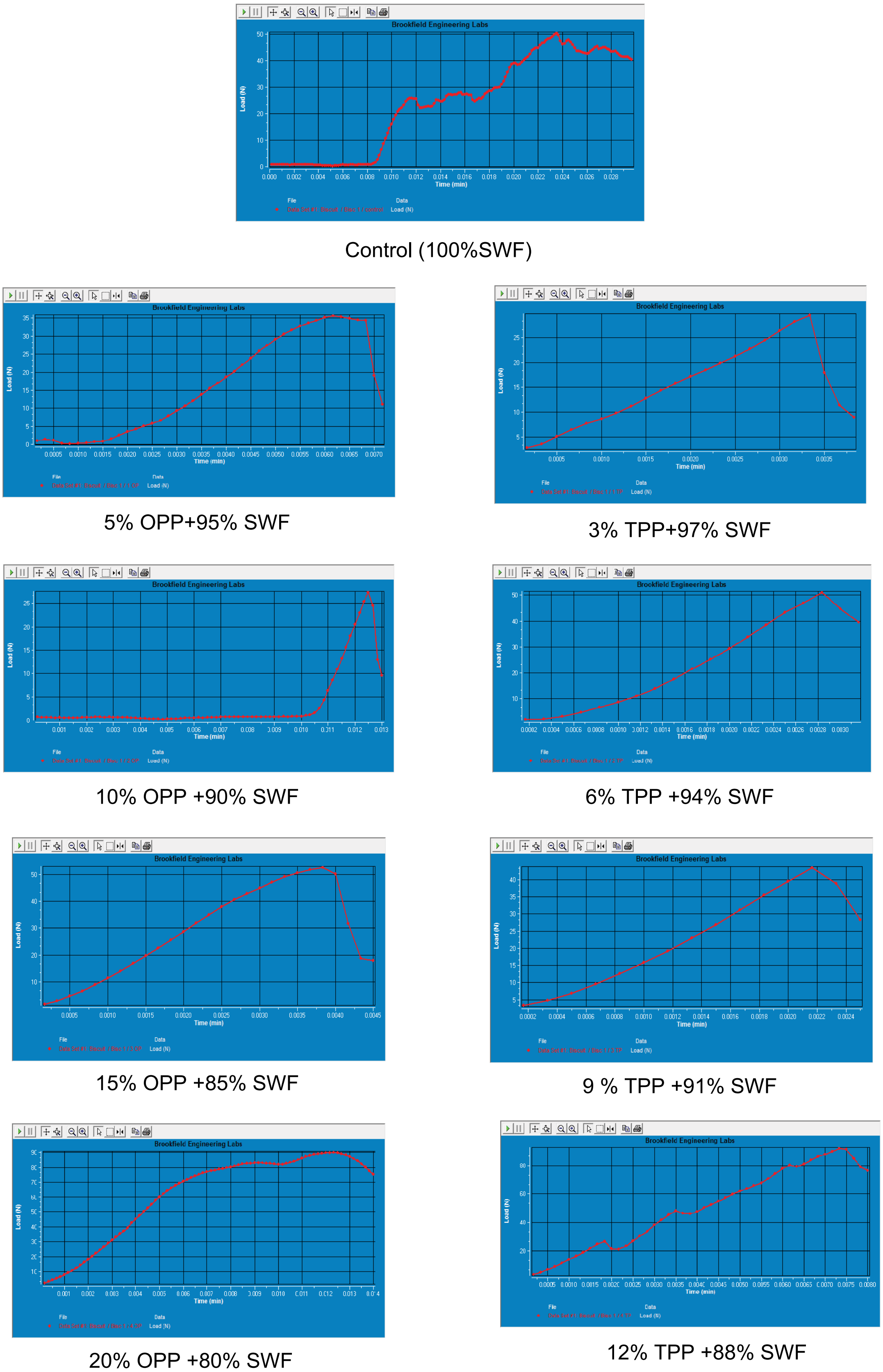
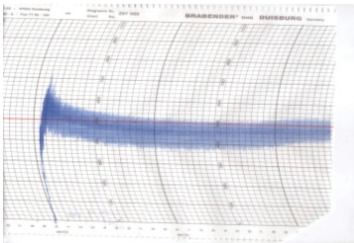
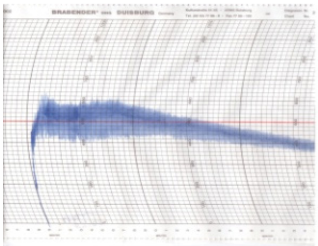


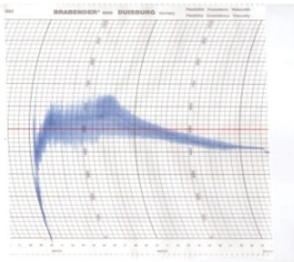
Figure 1. Texture profile of biscuit supplemented with OPP and TPP at different levels



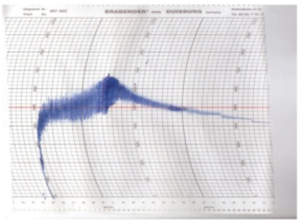
Control (100%SWF)



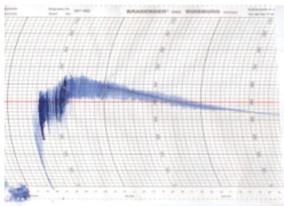
95% SWF+ 5%OPP



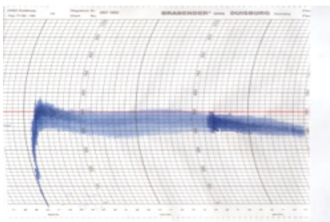
90% HWF+ 10%OPP



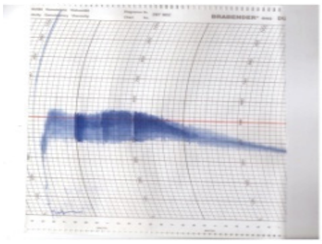
85% SWF+ 15%OPP



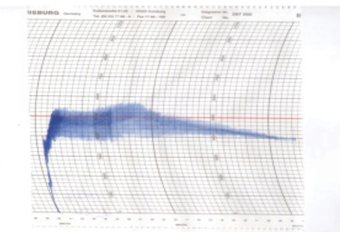
80% SWF+ 20%OPP



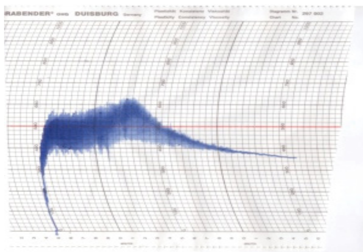
97% HWF+ 3%TPP



94% SWF+ 6%TPP



91%SWF+ 9% TPP



88% SWF+12%TPP

Figure 2. Farinograph parameters of dough sample supplemented with 5, 10, 15, 20% OPP and 3, 6, 9, 12% TPP

fiber content. Increased mixing tolerance and extension value may be possible, due to interactions between fibrous materials and gluten Sudha et al [26]. The dilution of gluten in the formulated flour decreased the interaction between starch and gluten and resulted in a higher mixing tolerance index Chen *et al*; Ogunsina et al [27,28].

Conclusion

Wheat flour biscuits fortified with OPP and TPP had an improved nutritional value. According to the obtained results, the overall acceptability of all the experimental biscuits fell within a suitable range but the biscuits with TPP and OPP up to 9% and 15%, respectively demonstrated the highest quality. Higher concentrations of OPP and TPP adversely affected the baking quality, color, and texture of the 5.0 experimental biscuits. However, the samples with 6% and 10% OPP demonstrated no significant changes in the sensory profile. Finally, Wheat flour could be replaced by 3.0 to 6.0% of TPP and to 10.0 % OPP with good properties and high nutritional value.

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