International Journal of Multiphysics
Volume 18, No. 1, 2024
ISSN: 1750-9548

Physico-Chemical, Rheological, Texture Profile and Sensorial Evaluation of Pan Bread Substituted by Jamun Seed Powder

Attiya S. Essia[1], Samy Abu-El Maaty[2], Elsayed Farahat[3], Alaa Samy Mohamed[1] and El Sayed Hassan Atwaa[2]

1 Department of Special Food and Nutrition, Food Technology Research Institute (FTRI), Agricultural Research Center (ARC), Egypt.

2 Department of Food Science (Food Industries), Faculty of Agriculture, Zagazig University, Egypt

3 Deputy Directors of Food Technology Research Institute, ARC, Egypt

Corresponding author: Attiya S. Essia

E-mail: foodcontrol9999@gmail.com

Abstract

The current study aimed to investigate the effect of replacing wheat flour used in loaf bread production with jamun seed powder at percentages of 2, 5, 7, and 10% on the rheological, physical, texture, and sensory properties of the resulting loaf. The results of the study showed that substituting wheat flour with JSP decreased the sensory qualities, volume, weight, and specific volume of the pan bread. Increasing the amount of JSP also affected the texture characteristics of the bread. Despite these changes, pan bread with 7.5% JSP had the closest texture to the control sample at 0 day. After one day of storage, pan bread with 5% JSP had the best texture profile among the substituted samples compared to the control. This is because most of the texture profile parameters of pan bread with 5% JSP were very close to those of the control (0% JSP) on day 0. On the other hand, the general food properties (sensory attributes and physical parameters) of the 10% JSP pan bread sample were relatively lower than the control. The 5% JSP-pan bread had higher sensory traits than the 10% JSP pan bread.

Keywords: Jamun seed powder (JSP), functional-pan bread, sensory attributes, diabetic rats, and serum glucose.

1. Introduction

The Jamun tree, Syzigium cumini, belongs to the family Myrtaceae and grows in tropical regions, mainly in Asia, the Americas, and Australia (**Ayyanar and Subash-Babu, 2012**). Bangladesh produced about 51,302 metric tonnes of Jamun fruit from 386 acres (4,047 m^2) of land in the agricultural season 2013 – 2014 (**BBS, 2015**).

Jamun fruit has other names, e.g., jambolan, black plum, jambolão, azeitona roxa and java plum (**Sari et al., 2012**). Both pulp and seed have a potential effect against diseases based on their high contents of phytochemicals such as anthocyanins, tannins, phenolic acid, flavonols, flavanonol, carotenoids, and terpenes (**Li et al., 2009**).

Several publications have attributed many health benefits to the phenolic compounds in Jamun fruit, e.g., anti-inflammatory, heart protection, protection for gastroduct, antidiabetic, bactericidal, antiviral, and antioxidant properties (**Ayyanar and Subash-Babu, 2012**). The ethanolic extract of Jamun seeds was reported to ameliorate alloxan-induced diabetes in rabbits (**Sharma et al., 2003**).

The Jamun fruit pulp was reported to contain 83.7% moisture, 0.7%protein, 0.3% fat, 0.9% crude fiber, 14% carbohydrates, and 0.4% ash, while Jamun seeds contain 6.63% protein, 0.66% fat, 75.4%, carbohydrates, and 1.32% water-insoluble fiber (**Chaudhary and Mukhopadhyay, 2012**).

Consumers nowadays consume healthy foods to avoid infectious diseases. So, industry agents and researchers exert considerable effort to improve the sensory properties of food items. Pan bread usually has a thin crust and a crumb with regular porosity, where its cells have thin walls and a particular structure different from other bread kinds (**Hathorn et al., 2008**). Moreover, its texture is soft and flexible because of the addition of fat, monoglycerides, milk powder, and sugar in the hodgepodge (**Besbes et al., 2014)**.

Egypt imports huge amounts of wheat due to poor subsidies, human overpopulation, and the local production of wheat is low (**Abdalla and Al-Shawarby, 2017**). The whole Egyptian population consumed 20.8 million tonnes of wheat from 2020 to 2021 while only producing 9.8 million tonnes of internal wheat, i.e., nearly 47% of the total consumption (**World Population Review, 2021**).

Nevertheless, wheat flour price is increasing yearly due to several uses for wheat flour in making cereal products and different sweets worldwide. In Egypt, bread is the backbone of Egyptian life, while the gap between production and consumption is wide. So this study aims to save tons of flour and hard currency by improving the Egyptian economy by replacing partially the flour with Jamun seeds powder, i.e., saving wheat flour consumption by about 2.08 million tonnes yearly if pan bread 10% JSP was used. The second aim is to help maintain the environmental balance by using Jamun seeds, currently considered agricultural waste in making pan bread.

2. Materials and Methods

Farinograph test

A Brabender Farinograph was used to study the hydration and mixing qualities of the dough under examination (**AACC, 2002**).

Extensograph test

The Extensograph test was performed according to the method depicted in **A.A.C.C. (2002),** using an extensograph device.

Preparation of pan bread

Pan bread loaves were prepared using the method described in **El-Porai et al. (2013).** A quantity (100 g) of wheat flour (72% extract), 1.5 g of instant active dry yeast, 2 g of salt, 2 g of sugar, 3 g of sunflower oil, water, and different levels of Jamun seeds powder (2.5%, 5%, 7.5%, and 10% of the flour) were used as replacements in pan bread (0% JSP) as a control sample. All formula ingredients were placed and mixed in a mixing bowl at 30 $^{\circ}$C for 6 minutes. After mixing, the dough of the pan bread was rounded by folding, and the dough was left for 15 minutes. After the preparation of the dough (120 grams), it was placed in a baking pan with a light oily layer. The loaves were fermented in a cabinet and baked in an electric Italian oven at 250 $^{\circ}$C for twenty minutes. The loaves were left to cool at room temperature and then packed in polyethylene bags, and the bags were stored in the fridge for cooling (5±1°C).

Sensory evaluation of pan bread

Samples of pan bread were coded, and a panel of fifteen members with great ability to evaluate sensory attributes was selected as judges. The judges used a sensory scale of five points, where 5 points indicate extremely like while one point signifies extremely dislike **(Ihekoronye and Ngoddy, 1985)**.

Pan bread volume

The specific volume of pan bread was measured via modification of the rapeseed replacement method (**AOAC, 2000**). Alfalfa seeds (1 liter) were used instead of rapeseed. A small amount of alfalfa seeds was

put in a one- liter glass beaker then and the loaf bread was placed. More alfalfa seeds were added to the beaker up to the mark of 1 liter. The loaf volume was concluded as the volume of the remaining seeds.

Specific volume

Specific volume was calculated according to the following equation: specific volume (cm^3/g) = loaf volume (cm^3) / weight of loaf (g).

Texture profile analysis

Texture profile analysis was done by texturometer specifically The AMETEK Brookfield CT3 Texture Analyzer located in Berwyn, Pennsylvania, USA. The apparatus including a cylinder probe, and its diameter was 36 mm. Pan bread was sliced into blocks with the exact dimensions and the slice was compressed twice to draw two bites texture profile curve. The parameters were evaluated by software within the apparatus (**Jensen et al., 2010**).

Statistical analysis

The obtained findings were analyzed using the analysis of variance (ANOVA) method, as described in reference **SAS (1996).**

3. Results and Discussion

Effect of JSP substitution on Farinograph parameters of the dough

From the data in (Table 1), there was a significant difference among doughs of JSP-pan bread compared to the control dough (0% JSP) at all the tested parameters at ($p< 0.001$). The control pan bread dough recorded 63% water absorption, while the highest level (64%) was achieved when the flour was substituted by 2.5% and 5% JSP. Higher JSP substitution levels (7.5 and 10% JSP) recorded lower water absorption percent values (63 and 61.9 %, respectively). So, the 2.5 and 5% JSP substitution levels had the highest influence on the water absorption percent.

Table 1. Effect of substitution of jamun seed powder (JSP) on Farinograph parameters of the pan bread

Farinograph parameters					
JSP substitution %	Water absorption (%)	Arrival time (min)	Dough development (min)	Stability time (min)	Degree of softening (B.U)
0%	63^{b}	$2^{a} \pm 0.1$	$7.9^{a} \pm 0.15$	$13.9^{a} \pm 0.61$	$59.6^{c} \pm 0.55$
2.5%	$64^{a} \pm 0.1$	$2^{a} \pm 0.2$	$7.9^{a} \pm 0.20$	$11.5^{c} \pm 0.55$	$69.7^{b} \pm 0.42$
5%	$64^{a} \pm 0.2$	$1.9^{a} \pm 0.35$	$7^{b} \pm 0.10$	$10.1^{d} \pm 0.32$	$69.8^{b} \pm 0.49$
7.5%	$63^{b} \pm 0.35$	$1.5^{b} \pm 0.25$	$7.9^{a} \pm 0.20$	$12.5^{b} \pm 0.45$	$49.6^{d} \pm 0.59$
10%	$61.9^{d} \pm 0.15$	$1.5^{b} \pm 0.15$	$7.9^{a} \pm 0.26$	$10.5^{d} \pm 0.45$	$89.03^{a} \pm 1$
P value	0.0001**	0.0088**	0.0004**	0.0001**	0.0001**
L.S.D	0.36	0.33	0.35	0.89	1.2

(**) means high significant difference.

The control pan bread (0% JSP) achieved the longest arrival time (2 minutes). Substituting with a lower level of JSP (2.5%) did not change the level of the control, while replacing with 5% JSP reduced the arrival time slightly to 1.9 minutes. Substitution with 7.5%, and 10% JSP produced the lowest arrival time value (1.5 minutes). The dough development times were similar to the control pan bread (0 % JSP) and the samples substituted with (2.5, 7.5, and 10% JSP), as they all recorded 7.9 minutes. However, the dough prepared from 5% JSP-substituted flour achieved the shortest development time (7 minutes). The

control dough (0 %JSP) exhibited the highest value of stability time (13.9 minutes), while substitution with JSP at different ratios (2.5, 7.5, and 10% JSP) lowered the stability time values into 11.5, 12.5, and 10.53 minutes, respectively. The lowest value of stability time (10.1 minutes) was noticed in the sample substituted with 5% JSP. Generally, the stability time values declined with the increase of JSP substitution. The highest softening degree value was 89.03 BU for pan bread (10% JSP). The pan bread substituted with 0, 2.5, and 5% JSP recorded lower degrees of softening values; 59.6, 69.7, and 69.8%, respectively. The lowest softening degree value (49.6 BU), was associated with 7.5% JSP substitution. The best treatment after control pan bread dough (0 % JSP) was the 7.5 %-substituted sample as it had suitable Farinograph parameters except for the arrival time. It exhibited the lowest degree of softening (49.6 BU) and its stability time (12.5 minutes), and its dough development time (7.9 minutes) matched that of the control dough (0% JSP). The results obtained in this study are in agreement with the findings of **Tuna Ağirbaş et al. (2022).**

Effect of JSP substitution on Extensograph parameters of the dough

The data in (Table 2) revealed highly significant differences between the JSP - substituted doughs and the control dough at ($P< 0.0001$) for all Extensograph parameters, except for extensibility at ($P< 0.01$). The highest elasticity value (489.3 BU) appeared for 2.5% JSP dough, while the lowest (409.3 BU) was associated with 10% JSP dough. The other doughs substituted with 0, 5, and 7.5 %JSP recorded medium degrees of elasticity, i.e., 483.3, 480, and 441 BU, respectively.

The highest extensibility (104.9 mm) was associated with the control dough (0 % JSP), while the lowest level (66.6 mm) was registered for 7.5% JSP substituted dough. The doughs substituted with 2.5, 5, and 10% JSP recorded medium degrees of extensibility i.e. 95, 90, and 69.9 mm, respectively.

The highest value of the proportional number (5.81) qualified the sample substituted with (10% JSP), while the lowest value (4.73) marked the 0% JSP substituted sample (control). Medium proportional numbers (5.16, 5.30, and 5.47) characterized the doughs substituted with 2.5, 5, and 7.5% JSP, respectively. The highest value of energy (54.9 cm^2) resulted from the control dough (0% JSP), while the lowest value (24.9 cm^2) resulted from the dough substituted with 10% JSP. The pan bread dough substituted with 2.5, 5, and 7.5% JSP recorded medium energy values; 39.9, 35.03, and 32.9 cm^2, respectively.

Finally, it was deduced that dough samples substituted with 2.5% and 5% JSP showed the nearest values to the control dough (0% JSP) regarding elasticity and extensibility. JSP substitution increased fiber content but reduced the glutenin protein amount. The obtained results agreed with **Lotfy and Bayomy (2017)** reporting that adding sweet potato powder at levels 10 and 20% fell the Extensograph parameters, e.g., elasticity, extensibility, proportional number, and energy.

Table 2. Effect of jamun seed powder (JSP) substitution on Extensograph parameters of pan bread

Extensograph parameters				
JSP substitution%	Elasticity (B.U)	Extensibility (mm)	Proportional number(P.N)	Energy(cm^2)
0%	$483.3^{a} \pm 3$	$104.9^{a} \pm 0.15$	$4.73^{e} \pm 0.04$	$54.9^{a} \pm 0.15$
2.5%	$489.3^{a} \pm 2$	$95^{a} \pm 0.35$	$5.16^{d} \pm 0.03$	$39.9^{b} \pm 0.21$
5%	$480^{a} \pm 3$	$90^{a} \pm 0.25$	$5.30^{c} \pm 0.03$	$35.03^{c} \pm 0.25$
7.5%	$441^{b} \pm 2.6$	$66.6^{b} \pm 0.23$	$5.47^{b} \pm 0.03$	$32.9^{d} \pm 0.22$
10%	$409.3^{c} \pm 2.1$	$69.9^{b} \pm 0.21$	$5.81^{a} \pm 0.04$	$24.9^{e} \pm 0.16$
P value	0.0001**	0.0038**	0.0001**<	0.0001**<
L.S.D	25.2	18.49	0.06	0.37

(**) means high significant difference $p \leq 0.01$

Effect of JSP substitution on pan bread physical traits

Significant differences among treatments and the control pan bread at ($P< 0.0001$) except for the weight $p< 0.01$ were noticed in (Table 3). The highest volume value of pan bread (570 cm^3) was recorded for the control pan bread (0% JSP). The pan bread substituted with 2.5, 5, 7.5 and 10% JSP recorded lower volume values, i.e., 530, 455, 422 and 392.7 cm^3, respectively. The control pan bread (0% JSP) recorded the lowest weight value, i.e., 187 g/loaf. The highest weight values were observed for pan bread (5 and 7.5% JSP), recording 196, and 195 g, respectively. Conversely, the pan bread substituted with 2.5% and 10% recorded lower weight values, i.e., 192, and 191 g, respectively.

The specific volume of JSP-substituted pan bread samples was reduced compared with control pan bread (0% JSP). There was a high significant difference among samples compared to the control pan bread (0% JSP) at $p< 0.0001$. The highest specific volume value was observed in the control pan bread (0% JSP), achieving 3.04 cm^3/g. The pan bread substituted with 2.5, 5, and 7.5% JSP recorded lower specific volume values, i.e., 2.8, 2.3, and 2.16 cm^3/g, respectively. The lowest value of specific volume was 2.05 cm^3/g substituted at 10% JSP.

Generally, the results obtained in this study are in agreement with the findings of **Lotfy and Bayomy (2017)** stating that the substitution of wheat flour with sweet potato flour at three replacement ratios, 10, 20 and 30%, changed the physical properties, i.e., the bread weight increased, but the volume and specific volume decreased. The decreased specific volume of the JSP-substituted bread may be due to the high water-holding capacity of Jamun seed powder and its high fiber content (7%). Additionally, Jamun seed powder does not have gluten protein, producing the sticky net enclosing the gases.

Table 3. Effect of jamun seed powder (JSP) substitution on volume, weight, and specific volume for produced pan bread

Parameters			
JSP substitution %	Volume (cm^3)	Weight (g)	Specific volume (cm^3/g)
0%	$570^{a} \pm 10$	$187^{d} \pm 0.6$	$3.04^{a} \pm 0.05$
2.5%	$530^{b} \pm 10$	$192^{bc} \pm 1$	$2.8^{b} \pm 0.1$
5%	$455^{c} \pm 5$	$196^{a} \pm 1$	$2.3^{c} \pm 0.02$
7.5%	$422^{d} \pm 3$	$195^{ba} \pm 2$	$2.16^{d} \pm 0.02$
10%	$392.7^{e} \pm 13$	$191^{c} \pm 4$	$2.05^{e} \pm 0.07$
L.S.D P value	16.1 < 0.0001**	3.7 < 0.01**	0.09 < 0.0001**

(**) means high significant difference $p\leq 0.01$.

Effect of JSP substitution on bread texture profile at 0 day and after 1 day.

The data in (Table 4) indicated highly significant differences among the samples compared with the control pan bread (0 % JSP) at ($p< 0.0001$) for all parameters, except for resilience at ($p< 0.01$). The hardness, the energy required to masticate the pan bread in the mouth, revealed its highest hardness value (24.12 N) for 10% JSP pan bread while its lowest value (13 N) for 2.5% JSP pan bread. The pan bread substituted with 0, 5, and 7.5% JSP, respectively, recorded medium values (16.5, 16.3, and 20.9 N)

Adhesiveness is the force required to tame the attraction power between the two surfaces of food and teeth achieved its highest value (0.97 mJ) for 5% JSP pan bread while its lowest value (- 0.09 mJ) for 7.5% JSP pan bread. The pan bread substituted with 0, 2.5, and 10% JSP recorded medium adhesiveness values, i.e., 0.30, 0.10, and 0.19 mJ, respectively.

Resilience, the ability of a food item to regain its normal shape after the first bite, recorded its maximum level (0.21) for control pan bread (0% JSP), whereas its minimum level (0.11) for 10% JSP pan bread.

The pan bread substituted with 2.5, 5, and 7.5% JSP recorded intermediate resilience values of 0.18, 0.15, and 0.14, respectively.

The cohesiveness force, defined as the attraction force among food particles to be sticky, was the highest (0.60) in control pan bread (0% JSP) and the lowest (0.40) in 10% JSP pan bread. Medium cohesiveness values; 0.52, 0.49, and 0.48 were recorded for pan bread substituted with 5, 2.5, and 7.5% JSP, respectively.

Springiness, the retriever food height after finishing the first bite and starting the second one, achieved its highest value (6.3 mm) for control pan bread while its lowest level (4.2 mm) for 2.5% JSP pan bread. Intermediate springiness levels (5.01, 5.8, and 4.3 mm) were associated with the bread substituted with 5, 7.5, and 10% JSP, respectively.

The gumminess, the product of multiplying the hardness by the cohesiveness, exhibited its maximum value (10.9 N) for control pan bread (0% JSP) and its minimum value (6.9 N) for 2.5% JSP pan bread. The pan bread substituted with 5, 7.5, and 10% JSP recorded medium gumminess values, i.e., 9.09, 10.8, and 10.3 N, respectively.

The chewiness is estimated as hardness × cohesiveness × springiness, the values reduced in JSP pan bread samples compared with the control pan bread. The highest value of chewiness (69.7 mJ) was recorded for control pan bread, while the lowest (29.3 mJ) was associated with 2.5% JSP pan bread. The pan bread substituted with 5, 7.5, and 10% JSP recorded intermediate chewiness values, i.e., 45.7, 62.2 and 44.5 mJ, respectively.

Generally, JSP substitution dropped the samples' resilience, cohesiveness, springiness, gumminess, and chewiness .7.5% JSP pan bread was the closest to control pan bread (0% JSP) values so far springiness, gumminess, cohesiveness, and chewiness parameters, so pan bread (7.5% JSP) was the best after the control pan bread.

After 1 day, high significant differences among the JSP samples and the control pan bread were noticed at ($p< 0.0001$) for all parameters, except resilience at ($p> 0.05$) and cohesiveness at ($p< 0.01$) in the same Table. The highest hardness value (23.1 N) was recorded for 10 % JSP pan bread, while the lowest value (12.9 N) was registered for the 2.5 % JSP pan bread. The other pan bread samples substituted with 0, 5, and 7.5 % JSP, respectively recorded medium hardness values (15.4, 20.7, and 13.8 N).

The highest adhesiveness value (1.19 mJ) was noticed for 0 % JSP pan bread, while the lowest one (0.01 mJ) was recorded for the 10% JSP pan bread. The pan bread substituted with JSP at 2.5, 5, and 7.5% JSP gave medium adhesiveness values, i.e., 0.31, 0.013, and 0.29 mJ, respectively.

The highest resilience level (0.18) was recorded for 5% JSP pan bread, while the lowest one (0.11) was noticed for both 7.5% pan bread and 10% JSP pan bread samples. Control sample (0% JSP) and lower substitution sample (2.5%JSP) gave medium resilience levels, i.e., 0.16 and 0.12, respectively.

The highest cohesiveness value (0.50) was recorded for 5% JSP pan bread, while the lowest value (0.39) was detected for the 7.5% JSP pan bread. The samples substituted with 0, 2.5, and 10% JSP recorded medium cohesiveness values (0.47, 0.40, and 0.41) respectively.

The 5% JSP pan bread exhibited the highest springiness value (6.11 mm), while the 7.5% JSP sample showed the lowest level (4.03 mm). The samples substituted with 0, 2.5, and 10% JSP produced medium levels, i.e., 5.1, 4.4, 5.6 mm, respectively.

The highest gumminess value (11.7 N) was noticed for both 2.5 and 5% JSP pan bread samples, while the lowest level (6.11 N) was observed for 7.5 % JSP pan bread sample. The control pan bread (0% JSP) and the highly substituted one (10 % JSP) showed medium levels, i.e., 7.9 and 10.5 N, respectively. Generally, the results obtained in this study are in agreement with the findings of **Zhang et al, (2023).**

Through one-day storage, it can be briefly deduced that 5% JSP pan bread had the highest values for resilience, cohesiveness, springiness, gumminess, and chewiness. Also pan bread (5% JSP) was the best treatment through one-day- storage because its most texture profile parameters (resilience, cohesiveness, gumminess, and chewiness) were very close to the parameters of control pan bread (0% JSP) at 0 day. All texture parameters of the control sample decreased except adhesiveness after storage for one day. According to **Heitmann et al. (28)** reported that low hardness is a desired trait since a high hardness value indicates bread staling and hard chewing.

Table 4. The texture profile of pan bread substituted with different proportions of jamun seed powder at 0 day and after 1 day

JSP substitution %	Hardness N	Adhesiveness m J	Resilience	Cohesiveness	Springiness mm	Gumminess N	Chewiness m J
Parameters of texture at 0 day							
0%	16.5^{c} ±0.04	0.30^{b} ±0.01	0.21^{a} ±0.03	0.60^{a} ±0.02	6.3^{a} ±0.03	10.9^{a} ±0.04	69.7^{a} ±0.04
2.5%	13^{d} ±0.25	0.10^{c} ±0.01	0.18^{ba} ±0.03	0.49^{b} ±0.02	4.2^{e} ±0.03	6.9^{e} ±0.03	29.3^{e} ±0.03
5%	16.3^{c} ±0.04	0.97^{a} ±0.15	0.15^{b} ±0.02	0.52^{b} ±0.06	5.01^{c} ±0.02	9.09^{d} ±0.05	45.7^{c} ±0.03
7.5%	20.9^{b} ±0.04	-0.09^{d} ±0.03	0.14^{b} ±0.03	0.48^{b} ±0.03	5.8^{b} ±0.06	10.8^{b} ±0.03	62.2^{b} ±0.03
10%	24.12^{a} ±0.02	0.19^{bc} ±0.04	0.11^{c} ±0.03	0.40^{c} ±0.03	4.3^{d} ±0.03	10.3^{c} ±0.04	44.5^{d} ±0.03
P value	0.0001** <	< 0.0001**	0.0025** <	< 0.0001**	< 0.0001**	< 0.0001**	< 0.0001**
L.S.D	0.22	0.13	0.04	0.04	0.06	0.07	0.05
Parameters of texture after 1 day							
0%	15.4^{c} ±0.03	1.19^{a} ±0.04	0.16^{ba} ±0.05	0.47^{b} ±0.05	5.1^{c} ±0.03	7.9^{c} ±0.07	40.9^{c} ±0.04
2.5%	12.9^{e} ±0.04	0.31^{b} ±0.04	0.12^{b} ±0.01	0.40^{b} ±0.03	4.4^{d} ±0.05	11.7^{a} ±0.08	71.6^{a} ±0.03
5%	20.7^{b} ±0.04	0.013^{c} ±0.01	0.18^{a} ±0.02	0.50^{a} ±0.02	6.11^{a} ±0.03	11.7^{a} ±0.07	71.6^{a} ±0.03
7.5%	13.8^{d} ±0.08	0.29^{b} ±0.02	0.11^{b} ±0.03	0.39^{b} ±0.0.03	4.03^{e} ±0.02	6.11^{c} ±0.03	24.6^{d} ±0.03
10%	23.1^{a} ±0.1	0.01^{c} ±0.03	0.11^{b} ±0.04	0.41^{b} ±0.03	5.6^{b} ±0.04	10.5^{b} ±0.04	59.5^{b} ±0.04
P value	0.0001** <	< 0.0001**	> 0.05 N.S	< 0. 01**	< 0.0001**	< 0.0001**	< 0.0001**
L.S.D	0.09	0.04	0.06	0.06	0.06	0.11	0.06

(**) means high significant difference p≤ 0.01. (N.S): means insignificant difference p> 0.05.

Effect of JSP substitution on sensory properties

From data in Table (5), it is noticed that there was a high significant difference among samples compared with control pan bread (0% JSP) at (p< 0.0001) concerning texture and taste, at (p< 0.001) for color and overall acceptability, and at (p< 0.01) for odor. The highest value of texture was recorded at 4.4 for control pan bread (0% JSP). The pan bread substituted with 2.5% and 5% JSP recorded lower texture values, i.e., 4.3 and 3.93, respectively. The lowest value of texture was 3.13 at the sample substituted at 7.5% JSP. The highest score for the color was 4.5 for control pan bread (0% JSP). The pan bread substituted with 2.5 and 5% JSP recorded lower color values 4.2, and 3.6, respectively. The lowest value of color was 3.1 for the sample substituted at 10% JSP. Control pan bread (0% JSP) had the highest score 4.6 in respect of the taste. The pan bread substituted with 2.5% and 5% JSP recorded lower taste values

4.4, and 3.8, respectively. The lowest value of taste was 2.9 for the sample substituted at 10 % JSP. Control pan bread (0% JSP) scored the highest value in respect of odor and overall acceptability, and the values were 4.5 for both. The lowest values of odor and overall acceptability were 3.4 and 3.17 in the samples substituted at 7.5 and 10% JSP, respectively. In general, the reduction of the sensory attributes results from the increase of substitution extent. Pan bread with low substitution extents (2.5 and 5% JSP), was the nearest to control pan bread with 0% JSP. The results generally agree with those **Thorat and Khemnar (2015)** who reported that color, appearance, taste, texture, flavor, and overall acceptability were reduced in Jamun seed powder-fortified cookies at high substitution levels (20 and 40%).

Table 5. Effect of jamun seed powder (JSP) substitution on sensory properties of fresh pan bread samples

Sensory attributes					
JSP substitution %	Texture (5)	Color (5)	Taste (5)	Odor (5)	Overall acceptability (5)
0%	4.4^{a} ±0.20	4.5^{a} ± 0.33	4.6^{a}±0.15	4.5^{a} ±0.16	4.5^{a} ±0.34
2.5%	4.3^{ab}±0.23	4.2^{a}±0.23	4.4^{a}±0.13	4.5^{a}±0.15	4.3^{ab}±0.20
5%	3.93^{b}±0.26	3.6^{b}±0.17	3.8^{b}±0.43	4.1^{b}±0.16	4^{b} ±0.12
7.5%	3.13^{c}±0.19	3.22^{c}±0.23	3.2^{c}±0.17	3.4^{b}±0.23	3.9^{b}±0.19
10%	3.16^{c}±0.27	3.1^{c}±0.27	2.9^{c}±0.25	3.8^{b}±0.26	3.17^{c}±0.24
L.S.D	0.42	0.45	0.46	0.36	0.42
P Value	<0.0001**	<0.001**	<0.0001**	<0.01**	<0.001**

(**) means high significant difference $p \leq 0.01$.

4. Conclusion

This study found that substituting wheat flour with JSP decreased the sensory qualities, volume, weight, and specific volume of the pan bread. Increasing the amount of JSP also affected the texture characteristics of the bread. Despite these changes, pan bread with 7.5% JSP had the closest texture to the control sample at 0 day. After one day of storage, pan bread with 5% JSP had the best texture profile among the substituted samples compared to the control. This is because most of the texture profile parameters of pan bread with 5% JSP were very close to those of the control (0% JSP) on day 0. The benefits of using JSP in pan bread include economic and environmental gains from using a cheap food waste product, as well as the health benefits of JSP's minerals and polyphenols.

References

[1] **AACC (2002) .** Approved Method of the AACC. 8th ed. Method 54-21. American Association of Cereal Chemists, St. Paul, MN, USA. http://dx.doi.org/10.1094/AACC.

[2] **Abdalla M, Al-Shawarby S. (2017).** The Tamween food subsidy system in Egypt: Evolution and recent implementation reforms. Faculty of Economics and Political Science, Cairo University. Accessed 26 Feb 2018**.**

[3] **AOAC (2000).** Official Methods of Food Analysis, 17th ed. Association of Official Analytical Chemists, Washington, DC, USA .

[4] **Ayyanar M, Subash-Babu P (2012) .(**Syzygium cumini L.) Skeels: A review of its phytochemical constituents and traditional uses. Asian Pacific Journal Tropical Biomedicine. 2: 240-246. https://doi: 10.1016/S2221-1691(12)60050-1.

[5] **BBS (Bangladesh Bureau of Statistics) (2015) .** Estimation of major and minor crops. Statistical year book of Bangladesh, static division, Ministry of planning, Govt. of Peoples Republic of Bangladesh, Dhaka. pp. 199-200

[6] **Besbes E, Jury V, Monteau JY et al (2014).** Effect of baking conditions and storage with crust on the moisture profile, local textural properties and staling kinetics of pan bread. LWT- Food Science and Technology. 58: 658-666. doi:10.1016/j.lwt.2014.02.037

[7] **Chaudhary B, Mukhopadhyay K (2012) .** Jamun (Syzygium cumini L.) Skeels : A potential source of nutraceuticals. International Journal of Pharmacy and Biology Science, (IJPBS). 2(1): 46-53.

[8] **El-Porai ES, Salama AE, Sharaf AM et al (2013).** Effect of different milling processes on Egyptian wheat flour properties and pan bread quality. Annals of Agricultural Science. 58(1): 51-59.doi:10.1016/ j.aoas.2013.01.008.

[9] **Hathorn CS, Biswas MA, Gichahi PN et al (2008).** Comparison of chemical, physical, micro-structural, and microbial properties of breads supplemented with Sweet Potato flour and high gluten dough enhancers. LWT- Food Science and Technology. 41(5): 803-815. http://dx.doi.org/10.1016/ j.lwt.2007.06.020

[10] **Heitmann M, Zannini E, Arendt EK (2015)** Impact of different beer yeasts on wheat dough and bread quality parameters. Journal of Cereal Science. 63: 49-56. http://dx.doi.org/10.1016/j.jcs.2015.02.008.

[11] **Ihekoronye AI, Ngoddy PO (1985).** Integrated Food Science and Technology for the Tropics, Tropical Fruits and Vegetables, Macmillan Education Ltd, New York. pp. 296-301 .

[12] **Jensen S, Oestdal H, Thybo AK (2010).** Sensory Profiling of Changes in Wheat and Whole Wheat Bread during a Prolonged period of storage. Journal of Sensory Studies. 25: 231-245 https://doi.org/10.1111/j.1745-459X.2009.00254.x **.**

[13] **Li L, Zhang Y, Seeram NP (2009).** Structure of anthocyanins from Eugenia jambolana fruit. Natural Product Communication. 4: 217-219. doi: 10.1177/ 1934578X0900400210

[14] **Lotfy LM, Bayomy HM (2017).** Quality of Pan Bread as Affected by the Incorporation of Sweet Potato Flour. Egyptian Journal of Food Science (EJFS). 45: 103-112**.**

[15] **Samba-Murthy AVSS, Subrah-manyan NS (1989).** Fruits. In: A Text Book of Economic Botany. Ed. V.S. Johry, 2 nd ed. Wiley Wiley-Eastern Ltd, New Delhi, India. pp. 629

[16] **Sari P, Wijaya CH, Sajuthi D, et al (2012**) **.**Colour Properties, stability, and free radical Scavenging activity of jambolan (Syzyguim cumini L.) fruit anthocyanins in a beverage model system: Natural and copigmented anthocyanins. Food Chemistry. 132(4):1908–1914. https://doi:10.1016/ j.foodchem.2011.12.025

[17] **SAS Institute (1996),** Inc. SAS User's Guide. Statistical Analysis Systems Institute, Cary, NC, Version 6.1. USA**.**

[18] **Sharma SB, Nasir A, Prabhu KM et al (2003).** Hypoglycaemic and hyperlipidemic effect of ethanolic extract of seeds of Eugenia jambolana in alloxan-induced diabetic rabbits. Journal of Ethnopharmacology. 85: 201-206. https://doi.org/10.1016/s0378-8741(02)00366-5

[19] **Thorat AV, Khemnar MB (2015).** Development and Sensory Evaluation of Jamun Seed Powder Fortified Cookies. International Journal of Science and Research (IJSR) 4(10): 184-187.

[20] **Tuna Ağirbaş, H. E., Yavuz-Düzgün, M., & Özçelik, B. (2022).** Valorization of fruit seed flours: rheological characteristics of composite dough and cake quality. Journal of Food Measurement and Characterization, 16(4), 3117-3129.

[21] **World Population Review (2021).** available at https://world population review.com / countries/Egypt- population

[22] **Zhang, G., Chatzifragkou, A., Charalampopoulos, D., & Rodriguez-Garcia, J. (2023).** Effect of defatted melon seed residue on dough development and bread quality. Lwt, 183, 114892.