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Quality Characteristics of Biscuits Supplemented With Pomace of Pomegranate Seed and Residual of Date Press

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Abstract

The aim of this study was to investigate the effect of replacement of wheat flour (72% ext.) with 20, 25 and 30% pomace of pomegranate seeds or date press powder on physico-chemical and organoleptic properties of sweet biscuit. The obtained data show that both pomace of pomegranate seeds and date press powder contained the highest amount from ether extract, ash and crude fiber. By increasing the percent of replacement with the previous two sources in the produced biscuits lead to increase of ether extract, ash, crude fiber and mineral contents, while crude protein, available carbohydrates and energy were gradually decreased compared with the control sample. Also, the moisture content and water activity values were increased significantly by increasing the replacement percent with pomace of pomegranate seeds or date press powder. During storage period the pH value of biscuit samples was significantly decreased by increasing the replacement percent with pomace of pomegranate seeds or date press powder. Also, results revealed that the pH value of all biscuits samples increased with the increase of storage period up to 6 months. At the same time, both of acid value and proxide value of biscuit samples significantly increased with increasing of storage period up to 6 months. Finally, it could be noted that, sweet biscuits produced by partially replacement of wheat flour with pomace of pomegranate seeds and date press powder until level 30% had characterized with a good sensory properties and acceptability.

KEYWORDS: Pomegranate seed pomace, date press pomace, biscuits, chemical and physical properties , storage effect.

Introduction

Biscuits are a successful product in the food industry. They are easy to carry and store, but the great majority of biscuits are rich in sugar and fat and they have sometimes been regarded as unhealthy foods **Conforti *et al*., (2012).** However, much research in recent years has focused on biscuit ingredients and proportions, which could be modified to achieve an alternative healthy product **(Yamsaengsung *et al.,* 2012). Kumar *et al*. (2017)** declared that huge amount of fruit and vegetable residues by-products from food sector industry increased continuously. **Liu (2004); Kiokias *et al.* (2016) and Varzakas *et al*. (2016)** pointed to the usefulness of plant residues containing bioactive phytochemicals related to health management, reduced risk of chronic diseases and could be directed to food-related industries.

Fruit wastes are naturally enriched with vitamins, minerals and other bioactive components and are good sources of fiber as well. Compelling evidences justify and designate peels and relative extracts of numerous fruits as nutraceutical and functional foods. In a present scenario of food insecurity related malnutrition and likelihood of infectious diseases, utilization of these healthier biological ingredients in diets have widely debated and established as reasonable strategies to address malnutrition and attenuate several health related disorders **(Akhtar *et al.,* 2013)**.

The physico-chemical stability of food depends greatly on the water content and its interaction with food ingredients. Analysis of moisture content of stored foods is a reliable assessment of the microbial growth and chemical stability of foods following manufacture **(Rahman and Labuza, 1999)**.

The pomegranate seeds contain approximately 3% of total fruit weight, which contains typically oil in the range of 12–20%. Conjugated fatty acids are present in many plant oils with varying concentrations including pomegranate seed oil. Conjugated fatty acids are the geometric and positional isomers of polyunsaturated fatty acids with alternate double bonds. These fatty acids received remarkable interest due to valuable physiological effects on various diseases. The pomegranate seed oil contains higher concentration (>70%) of conjugated fatty acids in the form of punicic acid (9cis, 11trans, 13cis-conjugated linolenic acid) **(Mahesar *et al.,* 2019)**. Seeds also contain protein, crude fibers, vitamins, minerals, pectin, sugars, polyphenols, isoflavones, the phytoestrogens, coumestrol and the sex steroid, estrone **(Aruna *et al*., 2016)**.

Date press cake as by-product during syrup (Debis) extraction are large amounts available. Depending on the method was used for juice extraction, date flesh with remaining sugar with or without date pit is left. Since date press cake is wet (about 70% moisture), bulky (it forms 30% of date weight), and easily deteriorated, it causes a disposal problem **(Al-Farsi *et al.,* 2007)**. Also, **Al-Farsi and Lee (2008)** reported that, date by-products have substantial amounts of dietary fiber, vitamins and total phenolics. This suggests that they are a good source for natural antioxidants, especially seed by-products and could serve either as a functional food or incorporated as an ingredient in functional food.

Peroxide value (PV) is an approximate indicator of state of oxidation but particularly in the early stage of oxidation it serves as a good tool for the measurement of degree of oxidation **(Mildner-Szkudlarz *et al*., 2009)**.

The aim of this study was to evaluated the effect of replacement of wheat flour (72% ext.) with 20, 25 and 30% pomace of pomegranate seeds or date press powder on physico-chemical and organoleptic properties of sweet biscuit.

Materials and Methods

Materials:

Pomegranate fruit (*Punica granatum* L.) was obtained from local market Inshas Al-Raml City, El-Sharkia Governorate, Egypt.

Date press (date fiber) (*Phoenix dactylifera* L.) a by-product of date syrup (Debis) was obtained from El-Tahhan Dates Company- Obour City-Cairo, Egypt.

Soft and semi hard wheat flour (72% extraction) was obtained from south Cairo Mills Company, Giza, Egypt. Other ingredients for baking process, i.e., sugar, butter, vanilla, baking powder and cacao were obtained from local market, Inshas Al-Raml City, El-Sharkia, Gavernorate, Egypt.

Chemicals used in this study were purchased from El-Gomhoria and El-Shark El-Aoust Companies, Cairo, Egypt.

Methods:

Preparation of pomegranate seeds pomace powder (PSP):

Pomegranate fruits were washed with clean running water to remove dust particles and to reduce the microbial load on the surface of the fruits. Pomegranate fruits were cut into four pieces then peeled off and arils were separated manually. These arils were passed through the juicer for extraction of juice. The residual distance juice extraction (seeds) dried in a ventilated oven at 120°C/30 min to inhibit the oxidative and pectin enzymes, increase the water evaporation and decrease the microbial load. The seeds were dried in a ventilated oven at 60°C until complete dryness. The dried seeds were grounded and the fine powder was sieved through a 60- mesh sieve, then it was stored at -18°C until used.

Preparation of date press pomace powder (DPP):

Date press pomace was obtained from Al-Tahhan Dates Company- Obour City, Cairo, Egypt. Date pomace was dried in a ventilated oven at 120°C /30 min to inhibit the oxidative and pectin enzymes, increase the water evaporation and decrease the microbial load. The date press was dried in a ventilated oven at 60°C until complete dryness. The dried date press were grounded and the fine powder was sieved through a 60-mesh sieve, then it was stored at -18°C until used.

Preparation of sweet biscuit:

The biscuit was prepared in the lab of Bread and Pastries Research, Food Technology Research Institute, Agric. Research Center. Ingredients used to make biscuit were given in Table (1) and (2). Biscuit was made according to the method described by **Wade (1988)** with some modification.

Table 1. Formula of sweet biscuit.

Ingredients	Amount (g)
Wheat flour (72% ext.)	**100**
Butter	**30**
Sugar	**30**
Baking powder	**3**
Vanilla	**1**
Water (ml)	**(25 - 36) as required**

For making biscuit: sugar, butter and vanilla were creamed by using a mixing machine for 1 min. Dry ingredients (wheat flour or its formulas and baking powder) were stirred together and added to the mixture gradually followed by beaten continuously. Then water added as require to obtained suitable smooth dough and the resulted dough was left to rest for 15 min. The dough was rolled in a cookie sheet using a guide roll. The dough was cut in circles (5 cm diameter and 0.3 cm thick) and the transferred to greased plate, then the baking process was carried out in an electrically heater oven at 170˚C for 12-15 min. After baking, biscuit was allowed to cool at room temperature for 1hr before sensory evaluation and storage for six months **(A.A.C.C., 2010).**

Table 2. Sweet biscuit formulas.

Treatments	(%) of replacement	Code	Soft wheat flour (72% ext.) (WF1) (g)	Semi hard wheat flour (72% ext.) (WF2) (g)	PSP (g)	DPP (g)	Cacao (g)	Sugar (g)	Butter (g)	Baking powder (g)	Vanilla (g)
Control .1. (Normal biscuit)		**B1**	**100**	**-**	**-**	**-**	**-**	**30**	**30**	**3**	**1**
Control .2. (Cacao biscuit).		**B2**	**-**	**70**	**-**	**-**	**30**	**30**	**30**	**3**	**1**
Pomegranate seeds pomace powder at replacement levels of	**20**	**B3**	**-**	**80**	**20**	**-**	**-**	**30**	**30**	**3**	**1**
	25	**B4**	**-**	**75**	**25**	**-**	**-**	**30**	**30**	**3**	**1**
	30	**B5**	**-**	**70**	**30**	**-**	**-**	**30**	**30**	**3**	**1**
Date press pomace powder at replacement levels of	**20**	**B6**	**-**	**80**	-	**20**	-	**30**	**30**	**3**	**1**
	25	**B7**	-	**75**	-	**25**	-	**30**	**30**	**3**	**1**
	30	**B8**	**-**	**70**	-	**30**	-	**30**	**30**	**3**	**1**

WF1: Soft wheat flour　　WF2: Semi hard wheat flour
PSP: Pomegranate seeds pomace powder　　DPP: Date press pomace powder

Sensory characteristics of experimental baked sweet biscuit:

A preliminary study was carried out for determination of the sensorial acceptable level of the mixed for investigated raw materials. The sensory characteristics of biscuits were evaluated according to the method of **San José *et al.* (2017)** and were carried out by a panel of ten experienced judges from the staff of the Food Technol. Res. Institute, Agric. Res. Center, Giza, Egypt. Assigning scores for various quality attributes such as: color (10), texture (10), taste (10), crust appearance (10), odor (10) and overall acceptability (10).

After identification of the best sensorial acceptable replacement percentage of the investigated raw material, the best treatment of biscuit was prepared as mentioned previously. After baking, biscuit were allowed to cool at the room temperature for 1hr then packaging as following: - Six pieces of biscuits (4-5g/each) were packed in transparence metalized orientated polypropylene (OPP) paper packages (20/20 microns) in Food Engineering and Packaging Department Agricultural Research Center to evaluation the products quality during storage time for 6 month at room temperature (25±2˚C) for shelf life**.** Also, resultant biscuits were chemically evaluation after baking.

Chemical analysis:

Moisture, crude protein, ash, crude fiber and ether extract content were determined according to the methods described by **A.O.A.C. (2012)** Available carbohydrates (A.C) was calculated by difference according to the following equation:

A.C =100 - % (moisture + protein + ether extract + ash+ crude fiber).

Minerals content, i.e., Ca, K, Mg, Na, Fe, Zn, Cu and Mn were determined by atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in **A.O.A.C. (2012)**.

Determination of total calories value:

Total calories were calculated using the compositional data by the equation mentioned by **FAO and WHO (1974)** and also by the following equation:

Total energy (Kcal/100 g) = 4(% carbohydrate +% protein) + 9 % fat

Where: energy as calories per/ 100g sample.

pH value:

The pH value was measured by using a pH meter Model Consort pH meter P107 according to the methods described by **(Najafi *et al*., 2012).**

Determination of water activity (wa):

Water activity (wa) was measured at 25°C using a Decagon Aqualab Meter Series 3TE (Pullman, WA, USA). All biscuit samples were broken into small pieces immediately before water activity measurement. The measurements were performed in triplicate (**Shahidi *et al*., 2008)**.

AV, FFA and PV value:

The acid value(AV), peroxide value (PV) and free fatty acids (FFA) were determined according to the methods described by **A.O.A.C. (2012).**

Color Measurements of Biscuit:

External color of the products was measured according to the method outlined by **McGurie (1992)** using a handheld Chromameter (model CR-400, Konica Minolta, Japan). Analyze and publish a set of Cartesian coordinates generated directly by the instrument. These coordinates pinpoint the measured color in a three-dimensional color space. However, without further manipulation, this information does not provide an indication of hue and chromo–aspects of color that are intuitively understood by those in the marketing chain from producer to consumer. The apparatus provided L^* (lightness with L^* = 100 for lightness, and L^* = zero for darkness), a^* [(chromaticity on green (−) to red (+)], b^* [(chromaticity on a blue (−) to yellow (+)], c (color saturation), h [(hue angle were 0˚ = red to purple, 90˚ = yellow, 180˚ = bluish to green and 270˚ = blue] scale.

Statistical Analysis:

The statistical analysis was carried out using SPSPS program (ver.25) with multi-function utility regarding to the experimental design under significance level of 0.05 for the whole results and multiple comparisons were carried out applying LSD according to **Steel *et al.* (1997)**.

Results and Discussion

Proximate chemical composition of used raw material:

The proximate chemical composition of raw materials under investigation is presented in Table (3). The obtained results revealed that date press powder (DPP) and pomegranate seeds powder (PSP) recorded significantly lower moisture content being 4.80 and 9.62 respectively, compared with 11.58 for soft wheat flour (WF1) and 13.39 for semi hard wheat flour (WF2). PSP contained significantly higher content from ether extract (3.50), ash (1.82) and crude fiber (11.66) followed by DPP being 2.58, 1.69 and 8.58 for the same parameters respectively. On the other hand, the significantly higher content of crude protein was recorded for semi hard wheat flour (12.82) followed by soft wheat flour (11.73) then pomegranate seed pomace powder (PSP) (11.31). Meanwhile, DPP had significantly lower crude protein content being 9.87. PSP had significantly lower content from available carbohydrate (71.71) followed by date press pomace powder (DPP) (77.28)

Table 3. Chemical composition of raw materials (mean±SE).

Materials	Moisture (%)	Crude protein* (%)	Ether extract* (%)*	Ash* (%)	Crude fiber* (%)	Available carbohydrate*@ (%)
Pomegranate seed pomace powder	**9.62^c ±0.14**	**11.31^c ±0.01**	**3.50^a ±0.06**	**1.82^a ±0.03**	**11.66^a ±0.10**	**71.71^c ±0.13**
Date press pomace powder	**4.80^d ±0.14**	**9.87^d ±0.05**	**2.58^b ±0.10**	**1.69^b ±0.03**	**8.58^b ±0.03**	**77.28^d ±0.14**
Soft wheat flour (72%ext.)	**11.58^b ±0.05**	**11.73^b ±0.07**	**0.63^c ±0.02**	**0.56^c ±0.01**	**0.19^c ±0.01**	**86.89^a ±0.09**
Semi-hard wheat flour (72%ext.)	**13.39^a ±0.03**	**12.82^a ±0.04**	**0.68^c ±0.01**	**0.63^c ±0.01**	**0.21^c ±0.02**	**85.66^b ±0.06**
LSD at 0.05	**0.33**	**0.16**	**0.20**	**0.07**	**0.17**	**0.35**

***: On dry weight basis.**

@ Available carbohydrate calculated by difference.

a, b & c: There is no significant difference (p≥0.05) between any two means, within the same column have the same superscript letter.

These data are similar with those reported by **Dadashi *et al*. (2013)** who found that crude protein ranged from 8.5±0.03 to 11.3±0.06% for seeds obtained from four Iranian commercial pomegranate varieties.

Proximate chemical composition of produced sweet biscuit formulas with pomace of pomegranate seeds and date press powders:

The proximate chemical composition of sweet biscuit with replacement (20, 25 and 30%) of PSP or DPP as a natural fiber and antioxidant were presented in Table (4). It could be noticed that the protein content was slightly decreased with increasing the percentage of PSP or DPP replacement from 20 to 30%. The sample of B8 contained significantly lower of protein content (6.64%) compared with control sample B1 (6.89%). While fat, ash and crude fiber contents were increased significantly by increasing the replacement of PSP or DPP replacement percentage. The sample of B5 recorded significantly higher content from fat (19.25%), ash (0.73%) and crude fiber (2.26%) compared with control sample B1 (18.64, 0.53 and 0.16%, respectively).

Available carbohydrate content was significantly decreased with increasing the percentage of PSP or DPP replacement from 20 to 30% while the sample of B5 had significantly lower content from available carbohydrate (70.84%) compared with control sample B1 (73.78%).

The increased fiber and the lower carbohydrate content of samples have several health benefits, as it will aid in the digestion in the colon and reduce constipation **(Elleuch *et al*., 2011).** According to well-documented studies, it is now accepted that dietary fibre plays a significant role in the prevention of several diseases such as; cardiovascular diseases, diverticulosis, constipation, irritable colon, cancer and diabetes **(Slavin, 2005 and Elleuch *et al*., 2011).**

Energy value is the amount of calorie available from food through oxidation and it is a function of the total protein, fat and carbohydrates present in the food. Data in Table (4) noticed that the energy value of the biscuit samples was decreased if the protein and available carbohydrates decreased. The Total caloric value (Kcal /100g) ranged from 484.17 where (B8) to 486.04 (B3) compared with control sample B1 (490.44). The rate of decrease in total caloric value for samples was ranged from 0.90 (B3) to 484.17 (B8) K.cal.

Our results are in agreement with the findings of **Hamoda (2018)** who mentioned that incorporated of wheat flour with date fiber in formulating pan and balady bread caused rising in ash, fiber content and lower protein, carbohydrate, fat and energy of produced pan and balady bread. **Abolila (2019)** found that pomegranate seed powder (PSPP) at levels (6, 9, 13.5 and 18%) fortified pan bread increased fiber, ash, fat and antioxidant activity and could provide health benefites to pan bread product.

Table 4, Chemical composition of produced sweet biscuit formulas with pomace of pomegranate seeds and date press powder (% on dry weight basis).

Component (%)	Biscuit formulas							
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Protein	**6.89^{B} ±0.04**	**7.63^{A} ±0.09**	**6.96^{B} ±0.02**	**6.94^{B} ±0.02**	**6.92^{B} ±0.03**	**6.81^{D} ±0.29**	**6.70^{C} ±0.07**	**6.64^{C} ±0.05**
Ether extract	**18.64^{F} ±0.05**	**20.77^{A} ±0.06**	**18.84^{D} ±0.04**	**18.99^{C} ±0.04**	**19.25^{B} ±0.05**	**18.62^{F} ±0.04**	**18.74^{E} ±0.03**	**18.85^{D} ±0.02**
Ash	**0.53^{F} ±0.11**	**0.76^{A} ±0.01**	**0.58^{D} ±0.01**	**0.63^{C} ±0.01**	**0.73^{B} ±0.01**	**0.59^{D} ±0.01**	**0.64^{C} ±0.01**	**0.73^{AB} ±0.01**
Crude fiber	**0.16^{G} ±0.01**	**1.98^{B} ±0.02**	**1.46^{E} ±0.02**	**1.83^{C} ±0.04**	**2.26^{A} ±0.06**	**1.23^{F} ±0.04**	**1.47^{E} ±0.01**	**1.79^{D} ±0.01**
Available Carbohydrate	**73.78^{A} ±0.09**	**68.86^{H} ±0.16**	**72.16^{D} ±0.02**	**71.61^{F} ±0.08**	**70.84^{G} ±0.10**	**72.75^{B} ±0.27**	**72.45^{C} ±0.07**	**71.99^{E} ±0.01**
Total caloric value (Kcal/100 g)	**490.44**	**492.89**	**486.04**	**485.11**	**484.29**	**485.82**	**485.26**	**484.17**

Values are mean±SE.

A, B & C: There is no significant difference ($p \geq 0.05$) between any two means, within the same row have the same superscript letter.

B1: 100%WF1 (Con. 1) B2: 70% WF2+30% Cacao (Con. 2)
B3: 80% WF2+20%PSP B4: 75%WF2+25%PSP
B5: 70%WF2+30%PSP B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP B8: 70% WF2+30% DPP

Minerals content of sweet biscuit formulas with pomace of pomegranate seeds and date press powders:

The obtained results from Table (5) indicated that all mineral contents in PSP and DPP supplemented sweet biscuit were increased by increasing the replacement percentage from 20 to 30%. But PSP supplemented sweet biscuit had the higher content from Cu, Ca, Mg, K and Zn than DPP supplemented sweet biscuit. While DPP supplemented sweet biscuit had the higher content from Fe and Na than PSP supplemented sweet biscuit. Sample B5 record the highest content from Cu, Mn, Ca, Mg, K and Zn contents (1.43, 0.49, 140.70, 64.00, 318.23 and 2.82 mg/100g, respectively), and Sample B8 record the highest value in Fe and Na (4.68 and 39.18 mg/100 g, respectively). Hence, sweet biscuit containing PSP or DPP are favorable than the control biscuit (B1) because of their high content of important minerals which depend upon the PSP or DPP percentage of replacement. The increase of mineral content of sweet biscuit may be due to the high levels of these minerals in PSP or DPP.

Table 5. Minerals content of produced sweet biscuits with pomace of pomegranate seeds and date press powders (mg/100 g on dry weight basis**).**

Minerals	Sweet biscuit formulas							
	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
Ca	**54.60**	**79.63**	**120.39**	**127.60**	**140.70**	**86.95**	**103.03**	**116.80**
K	**101.82**	**769.46**	**201.23**	**261.57**	**318.23**	**138.53**	**149.66**	**179.03**
Mg	**29.30**	**100.03**	**49.70**	**55.12**	**64.00**	**36.11**	**38.70**	**46.70**
Na	**20.74**	**26.36**	**28.99**	**29.51**	**30.54**	**33.13**	**36.37**	**39.18**
Fe	**2.03**	**2.18**	**2.45**	**2.71**	**3.06**	**3.23**	**3.92**	**4.68**
Zn	**1.53**	**2.96**	**2.20**	**2.37**	**2.82**	**1.61**	**1.74**	**2.09**
Cu	**0.54**	**0.68**	**1.15**	**1.18**	**1.43**	**0.73**	**0.87**	**1.10**
Mn	**0.25**	**1.07**	**0.40**	**0.44**	**0.49**	**0.29**	**0.39**	**0.45**

B1: 100%WF1 (Con. 1) B2: 70% WF2+30% Cacao (Con. 2)
B3: 80% WF2+20%PSP B4: 75%WF2+25%PSP
B5: 70%WF2+30%PSP B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP B8: 70% WF2+30% DPP

Similar observations were observed by other authors **Hamoda (2018)** who mentioned that incorporated of wheat flour with date fiber in formulating pan and balady bread caused rising in minerals content of produced pan and balady bread**.** Also **Sheir-Marwa (2022)** who mentioned that date press cake can be used as an ingredient to improve the nutritional quality of vegan biscuits.

Effect of storage period on moisture content and water activity of sweet biscuit formulas :

Data in Table (6) showed that moisture content was increased significantly by increasing replacement percent of PSP in (B3, B4 and B5) or DPP in (B6, B7 and B8). Also, it could be noticed that increasing storage period from zero time to 6 months was accompanied by significant increase in moisture content from 5.60 to 5.92%. Biscuits absorbed the humidity during storage, and, consequently, their water activity increased. The equilibrium was reached after 6 months with a water activity of 0.449.

Previous works have indicated that the increase in moisture content could be explained by the hygroscopic nature of biscuits, storage conditions and the packaging material **(Nagi *et al*., 2012).** Water absorption was probably the main limiting factor of biscuit shelf life. The water activity is a very important parameter to evaluate the microbiological stability of the product **(Huchet *et al*., 2013).** The maximum value of water activity 0.471 reached in the present work is low enough to avoid microbial growth. However, the acceptability of the product may change. According to **Hough *et al*. (2001),** the crunchiness of biscuits decreases sharply when the water activity increases from 0.4 to 0.6.

Table 6. Effect of storage period on moisture content and water activity of sweet biscuit formulas (mean±SE).

formulas	Storage period (month) 0	2	4	6	Mean of period
	Moisture content				
B1	**5.18±0.07[fC]**	**5.22±0.07[eC]**	**5.33±0.01[gB]**	**5.57±0.02[fA]**	**5.33±0.05[f]**
B2	**5.53±0.12[dC]**	**5.77±0.08[cB]**	**5.81±0.99[dB]**	**6.00±0.02[bA]**	**5.78±0.06[c]**
B3	**5.37±0.03[eC]**	**5.56±0.03[dB]**	**5.61±0.01[fAB]**	**5.66±0.01[eA]**	**5.55±0.03[e]**
B4	**5.66±0.12[bcC]**	**5.79±0.01[bcB]**	**5.85±0.01[cdA]**	**5.89±0.01[cA]**	**5.80±0.04[bc]**
B5	**6.25±0.13[aC]**	**6.37±0.04[aB]**	**6.48±0.02[aA]**	**6.53±0.01[aA]**	**6.41±0.04[a]**
B6	**5.50±0.08[eC]**	**5.62±0.06[dB]**	**5.72±0.02[eA]**	**5.75±0.01[dA]**	**5.63±0.04[d]**
B7	**5.65±0.03[cC]**	**5.82±0.03[bB]**	**5.92±0.02[bcA]**	**5.97±0.02[bA]**	**5.84±0.04[bc]**
B8	**5.73±0.05[bD]**	**5.85±0.03[bC]**	**5.93±0.02[bB]**	**6.01±0.03[bA]**	**5.88±0.03[b]**
Mean of formulas	**5.60±0.07[D]**	**5.75±0.06[C]**	**5.83±0.06[B]**	**5.92±0.06[A]**	
	(Wa)				
B1	**0.350±0.001[aD]**	**0.445±0.002[aC]**	**0.536±0.002[aB]**	**0.553±0.001[aA]**	**0.471±0.024[a]**
B2	**0.220±0.001[cD]**	**0.339±0.002[cC]**	**0.430±0.007[cB]**	**0.434±0.006[cA]**	**0.356±0.026[d]**
B3	**0.271±0.001[bC]**	**0.349±0.002[bB]**	**0.449±0.003[bA]**	**0.452±0.002[bA]**	**0.380±0.023[b]**
B4	**0.205±0.005[dC]**	**0.345±0.001[bB]**	**0.447±0.003[bA]**	**0.449±0.001[bA]**	**0.362±0.03[c]**
B5	**0.142±0.001[eD]**	**0.327±0.002[dC]**	**0.431±0.001[cB]**	**0.435±0.002[cA]**	**0.334±0.036[e]**
B6	**0.146±0.001[eD]**	**0.346±0.004[bC]**	**0.425±0.008[dB]**	**0.430±0.001[cA]**	**0.337±0.035[e]**
B7	**0.120±0.001[fC]**	**0.310±0.002[eB]**	**0.420±0.007[dA]**	**0.423±0.001[dA]**	**0.318±0.037[f]**
B8	**0.117±0.001[fC]**	**0.301±0.005[fB]**	**0.409±0.001[eA]**	**0.411±0.003[eA]**	**0.309±0.036[g]**
Mean of formulas	**0.196±0.016[D]**	**0.345±0.009[C]**	**0.443±0.008[B]**	**0.449±0.009[A]**	

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

B1: 100%WF1 (Con. 1) B2: 70% WF2+30% Cacao (Con. 2)
B3: 80% WF2+20%PSP B4: 75%WF2+25%PSP
B5: 70%WF2+30%PSP B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP B8: 70% WF2+30% DPP

Effect of storage period on acid value (AV) of sweet biscuit formulas:

Data in Table (7) showed that AV significantly decreased by increasing replacement percent of PSP, while, it is increased significantly by increasing replacement of DPP levels. Also results revealed that the AV of biscuits samples increased with increasing of storage period up to 6 months. The AV is the number of mg of KOH required to neutralize the free fatty acids present in 1 g of oil or fat. A small quantity of free fatty acid is usually present in oils along with the triglycerides. According to **Demain (1990)**. AV is used to measure the extent to which glyceride in the oil has been decomposed by lipase and other actions such as light and heat.

Effect of storage period on FFA of sweet biscuit formulas:

Data in Table (7) indicated that FFA significantly increased as increase in storage duration in all samples of biscuit, The increase in FFA content of soy biscuits was due to greater increase in their moisture content which promoted fat hydrolysis during storage **Singh *et al*. (2000)**.

Noteworthy increase in percent free fatty acids content was recorded with the lengthening of storage period.

Effect of storage period on PV of sweet biscuit formulas:

Data in Table (7) showed that significant decreases were found in PV means value for biscuits samples with increased the replacement percent of PSP or DPP. Also, the obtained data revealed that the PV of all biscuits samples increased with the increase of storage period up to 6 months. At the end of the storage period, the PV values of all biscuit was lower than the permissible value (10 mlequivalent O2 / Kg fats according to the **Egyptian Specification standard No 416 (2003)**. These are due to deferent their content of the antioxidant **(Priecina and Karklina, 2014)**.

The results concluded that the replacement of biscuit formulas with PSP or DPP were improving the oxidation stability of biscuit samples.

Table 7. Effect of storage period on pH, AV, FFA, and PV of sweet biscuit formulas (mean±SE).

formulas	Storage period (month)				Mean of period
	0	2	4	6	
			pH		
B1	9.15±0.04^{aC}	8.84±0.01^{aD}	9.65±0.03^{aB}	9.72±0.01^{aA}	9.34±0.11^{a}
B2	7.15±0.01^{bC}	6.61±0.01^{bD}	7.48±0.01^{bB}	7.53±0.01^{cA}	7.19±0.11^{b}
B3	6.85±0.01^{cC}	6.35±0.01^{dD}	7.18±0.01^{dB}	7.23±0.01^{eA}	6.90±0.11^{d}
B4	6.39±0.02^{fC}	6.21±0.18^{eD}	6.88±0.03^{eB}	6.91±0.01^{fA}	6.60±0.10^{f}
B5	6.22±0.04^{gC}	5.97±0.00^{fD}	6.73±0.02^{fB}	6.81±0.01^{gA}	6.43±0.11^{g}
B6	6.81±0.00^{cC}	6.56±0.02^{bD}	7.53±0.02^{bB}	7.65±0.01^{bA}	7.14±0.14^{b}
B7	6.60±0.01^{dC}	6.46±0.01^{cD}	7.31±0.01^{cB}	7.52±0.02^{cA}	6.97±0.14^{c}
B8	6.50±0.02^{eC}	6.36±0.00^{dD}	6.93±0.02^{eB}	7.43±0.01^{dA}	6.81±0.13^{e}
Mean of formulas	6.96±0.18^{C}	6.67±0.18^{D}	7.46±0.18^{B}	7.60±0.18^{A}	
			(AV)		
B1	0.53±0.01^{fD}	0.73±0.04^{Cf}	1.39±0.01^{cB}	2.25±0.02^{bA}	1.22±0.20^{c}
B2	6.72±0.02^{aD}	7.21±0.06^{aC}	7.76±0.02^{aB}	8.31±0.02^{aA}	7.48±0.18^{a}
B3	1.26±0.01^{bC}	0.82±0.08^{eD}	1.33±0.02^{deB}	1.44±0.01^{dA}	1.21±0.07^{c}
B4	1.17±0.01^{cC}	0.77±0.06^{ef}	1.27±0.02^{efB}	1.35±0.01^{efA}	1.14±0.07^{de}
B5	1.11±0.01^{cdC}	0.74±0.08^{fD}	1.24±0.01^{fgB}	1.30±0.01^{fgA}	1.10±0.07^{e}
B6	0.72±0.03^{eD}	0.93±0.09^{dC}	1.20±0.01^{gB}	1.28±0.01^{gA}	1.03±0.07^{f}
B7	1.03±0.02^{dC}	1.05±0.03^{cC}	1.31±0.00^{eB}	1.37±0.01^{eA}	1.19±0.05^{cd}
B8	1.21±0.03^{bD}	1.26±0.17^{bC}	1.53±0.01^{bB}	1.63±0.02^{cA}	1.41±0.06^{b}
Mean of formulas	1.72±0.40^{C}	1.69±0.43^{C}	2.13±0.44^{B}	2.36±0.47^{A}	
			(% FFA)		
B1	0.26±0.01^{fD}	0.36±0.02^{fC}	0.70±0.00^{cB}	1.13±0.0^{bA}	0.61±0.10^{c}
B2	3.38±0.01^{aD}	3.63±0.03^{aC}	3.90±0.01^{aB}	4.18±0.01^{aA}	3.77±0.09^{a}
B3	0.63±0.01^{bD}	0.42±0.04^{eC}	0.67±0.01^{cdB}	0.72±0.00^{dA}	0.61±0.04^{c}
B4	0.59±0.00^{cD}	0.39±0.03^{efC}	0.64±0.01^{dB}	0.67±0.00^{efA}	0.57±0.03^{d}
B5	0.55±0.01^{dD}	0.37±0.04^{fC}	0.62±0.00^{efB}	0.65±0.00^{fA}	0.55±0.03^{de}
B6	0.36±0.01^{eD}	0.47±0.05^{dC}	0.60±0.01^{fB}	0.64±0.01^{fA}	0.52±0.04^{e}
B7	0.52±0.01^{dD}	0.52±0.02^{cC}	0.66±0.00^{cB}	0.69±0.01^{deA}	0.60±0.02^{c}
B8	0.61±0.01^{bcD}	0.63±0.08^{bC}	0.77±0.01^{bB}	0.82±0.01^{cA}	0.71±0.03^{b}
Mean of formulas	0.86±0.20^{D}	0.85±0.22^{C}	1.07±0.22^{B}	1.19±0.24^{A}	
			(PV)		
B1	4.72±0.04^{bD}	5.42±0.10^{bC}	7.54±0.02^{aB}	9.67±0.01^{aA}	6.84±0.58^{b}
B2	6.67±0.04^{aD}	6.85±0.25^{aC}	7.41±0.03^{abB}	7.95±0.01^{eA}	7.22±0.16^{a}
B3	4.70±0.11^{bD}	5.59±0.43^{bC}	7.30±0.01^{bB}	9.10±0.03^{bA}	6.67±0.52^{b}
B4	3.40±0.05^{dD}	5.03±0.32^{cC}	6.96±0.03^{cB}	8.80±0.03^{cA}	6.05±0.62^{c}
B5	2.38±0.10^{eD}	4.27±0.24^{eC}	6.54±0.05^{dB}	8.24±0.01^{dA}	5.36±0.67^{e}
B6	4.62±0.08^{bD}	4.93±0.30^{cC}	6.46±0.02^{dB}	8.10±0.02^{deA}	6.03±0.42^{c}
B7	4.13±0.15^{cD}	4.50±0.25^{dC}	6.10±0.03^{eB}	7.68±0.04^{fA}	5.60±0.43^{d}
B8	3.37±0.15^{dD}	4.09±0.17^{eC}	5.85±0.02^{fB}	7.36±0.01^{gA}	5.17±0.47^{e}
Mean of formulas	4.25±0.25^{D}	5.09±0.19^{C}	6.77±0.12^{B}	8.36±0.15^{A}	

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

B1: 100%WF1 (Con. 1)
B2: 70% WF2+30% Cacao (Con. 2)
B3: 80% WF2+20%PSP
B4: 75%WF2+25%PSP
B5: 70%WF2+30%PSP
B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP
B8: 70% WF2+30% DPP

Effect of storage period on color of sweet biscuit formulas:

Data in Table (8) indicated that the color of biscuit samples was greatly affected by the replacement of wheat flour with PSP and DPP. This product was very dark, similar to ground coffee or cacao, with DPP being a little lighter than PSP. It could be demonstrated that almost characteristics of color lightness (L), yellowness (b), chroma (c) and hue angle (h) were decreased by increasing the replacement percent from 20 to 30% for both PSP and DPP. B8 sample was recorded the lowest value of L, b, c and h (47.77, 8.29, 10.09 and 54.07, respectively) compared with B1 (74.94, 24.51, 24.71 and 82.83, respectively) at zero time of storage. Redness (a) increased as percent of replacement went up, and B5 sample was recorded the highest value of a (7.99) compared with B1 (3.11). Also, the results revealed that the L and a of all biscuits samples decreased with the increase of storage period up to 6 months, while b, c and h were increased. The color intensity is related with many factors: the baking time of the dough; the contact and temperature in the baking plates or the colors formulation of raw material, thus different colors originate was found **(Purlis, 2010).** The color of the cookies' top surface was generated in the baking process possibly due to non-enzymatic browning (Maillard reactions) between reducing sugars and amino acids, but also possibly to starch dextrinisation and sugar caramelisation. Also the protein content has a negative correlation with the whiteness **(Chevallier *et al*., 2000).**

Color is a vital quality attribute of foods and plays on important role in sensory and consumer acceptance of products which exists by Millard reaction during biscuit baking **(Purlis, 2010).**

Table 8. Effect of storage period on color L*, a*, b*, c* and h* of sweet biscuit formulas (mean±SE).

formulas	Storage period (month)				Mean of period
	0	2	4	6	
			lightness (L*)		
B1	**74.94±1.00^{aD}**	**76.53±0.69^{aB}**	**79.53±0.80^{aA}**	**75.31±0.36^{aC}**	**76.58±0.63^{a}**
B2	**43.47±0.20^{gA}**	**30.50±0.52^{gC}**	**26.83±0.15^{gD}**	**32.11±1.93^{hB}**	**33.23±1.92^{h}**
B3	**58.40±1.41^{bB}**	**59.96±0.47^{bA}**	**55.28±0.40^{bD}**	**56.73±0.62^{aC}**	**57.59±0.64^{b}**
B4	**56.29±1.05^{cA}**	**56.57±0.33^{cA}**	**49.88±0.47^{cC}**	**51.55±0.40^{cB}**	**53.57±0.92^{c}**
B5	**55.72±1.09^{cA}**	**55.83±0.12^{cA}**	**47.13±0.66^{dD}**	**50.42±0.28^{dC}**	**52.28±1.15^{d}**
B6	**51.71±0.31^{dA}**	**49.87±0.61^{dB}**	**50.69±0.16^{cB}**	**44.67±0.32^{eC}**	**49.24±0.83^{e}**
B7	**48.96±0.64^{eA}**	**47.59±0.69^{eB}**	**44.18±0.78^{eC}**	**41.30±1.29^{fD}**	**45.51±0.98^{f}**
B8	**47.77±0.37^{fA}**	**41.41±1.13^{fB}**	**36.51±0.40^{fD}**	**38.03±0.69^{gC}**	**40.93±1.34^{g}**
Mean of formulas	**54.66±1.89^{A}**	**52.28±2.66^{B}**	**48.76±3.00^{C}**	**48.76±2.61^{C}**	
			Redness (a*)		
B1	**3.11±0.55^{gA}**	**1.73±0.14^{fB}**	**0.17±0.03^{eD}**	**0.75±0.13^{eC}**	**1.44±0.36^{e}**
B2	**5.22±0.38 ^{C}**	**6.97±0.12^{cA}**	**5.89±0.2^{cB}**	**6.10±0.38^{cB}**	**6.05±0.23^{d}**
B3	**6.92±0.23^{cA}**	**5.47±0.14^{eB}**	**5.41±0.23^{dB}**	**5.63±0.07^{dB}**	**5.86±0.2^{d}**
B4	**7.58±0.35^{bB}**	**8.23±0.27^{aA}**	**6.79±0.24^{bC}**	**7.47±0.09^{aB}**	**7.52±0.19^{b}**
B5	**7.99±0.45**^{aB}	**8.25±0.28^{aA}**	**8.20±0.27^{aA}**	**7.78±0.04^{aB}**	**8.06±0.14^{a}**
B6	**6.17±0.01**^{dA}	**5.88±0.31^{dB}**	**5.45±0.14^{dC}**	**5.84±0.08^{cdB}**	**5.83±0.11^{d}**
B7	**6.00±0.09^{dB}**	**6.77±0.10^{cA}**	**5.50±0.43^{dC}**	**6.50±0.60^{bA}**	**6.19±0.22^{d}**
B8	**5.69±0.33^{eC}**	**7.64±0.17^{bA}**	**6.68±0.11^{bB}**	**6.69±0.14^{bB}**	**6.68±0.23^{c}**
Mean of formulas	**6.09±0.31^{B}**	**6.37±0.42^{A}**	**5.51±0.47^{C}**	**5.85±0.43^{B}**	
			Yellowness (b*)		
B1	**24.51±0.30^{aB}**	**31.56±0.54^{aA}**	**20.64±0.71^{aC}**	**24.10±0.14^{aB}**	**25.20±1.21^{a}**
B2	**4.50±0.71^{eC}**	**13.44±0.31^{gA}**	**7.52±0.34^{gB}**	**8.71±0.26^{gB}**	**8.54±0.99^{h}**
B3	**16.37±1.78^{bD}**	**30.32±0.46^{bA}**	**19.04±0.03^{bC}**	**19.89±0.03^{bB}**	**21.41±1.65^{b}**
B4	**15.73±1.53^{bC}**	**28.42±0.20^{cA}**	**18.59±0.46^{bcB}**	**19.21±0.06^{bcB}**	**20.49±1.48^{cd}**
B5	**15.57±1.32^{bD}**	**27.19±0.67^{dA}**	**17.88±0.39^{cC}**	**18.76±0.45^{cB}**	**19.85±1.37^{d}**
B6	**10.96±0.70^{cD}**	**23.23±0.81^{eA}**	**16.33±0.14^{dB}**	**15.64±0.14^{dC}**	**16.54±1.34^{e}**
B7	**9.06±0.50^{dC}**	**23.27±0.08^{eA}**	**14.80±0.51^{eB}**	**14.39±0.12^{eB}**	**15.38±1.54^{f}**
B8	**8.29±0.65^{dC}**	**22.22±0.07^{fA}**	**12.98±0.19^{fB}**	**13.42±0.18^{fB}**	**14.23±1.52^{g}**
Mean of formulas	**13.13±1.25^{D}**	**24.96±1.14^{A}**	**15.97±0.83^{C}**	**16.76±0.92^{B}**	
			chroma (c)		
B1	**24.71±0.23^{aB}**	**31.59±0.53^{aA}**	**20.64±0.71^{aD}**	**24.12±0.15^{aC}**	**25.26±1.21^{a}**
B2	**6.90±0.76^{eD}**	**15.14±0.33^{fA}**	**9.56±0.39^{eC}**	**10.63±0.43^{fB}**	**10.56±0.92^{g}**
B3	**17.80±1.62^{bD}**	**31.42±0.51^{aA}**	**19.80±0.05^{aC}**	**20.67±0.02^{bB}**	**22.42±1.64^{b}**

B4	**17.64±1.24^{bD}**	**29.42±0.21^{bA}**	**19.79±0.35^{aC}**	**20.61±0.07^{bB}**	**21.87±1.38^{c}**
B5	**17.42±1.05^{bD}**	**27.74±0.68^{cA}**	**19.68±0.43^{aC}**	**20.32±0.41^{bB}**	**21.29±1.21^{c}**
B6	**12.56±0.59^{cC}**	**24.41±0.13^{dA}**	**17.21±0.17^{bB}**	**16.69±0.16^{cB}**	**17.72±1.29^{d}**
B7	**10.90±0.47^{dC}**	**23.96±0.86^{deA}**	**15.79±0.62^{cB}**	**15.81±0.35^{dB}**	**16.62±1.44^{e}**
B8	**10.09±0.40^{dC}**	**23.50±0.10^{eA}**	**14.60±0.19^{dB}**	**14.99±0.19^{eB}**	**15.79±1.46^{f}**
Mean of formulas	**14.75±1.14^{D}**	**25.90±1.07^{A}**	**17.13±0.74^{C}**	**17.98±0.83^{B}**	
			hue angle (*h*°)		
B1	**82.83±1.34^{aD}**	**91.94±0.45^{aA}**	**89.52±0.09^{aB}**	**88.22±0.29^{aC}**	**88.13±1.05^{a}**
B2	**40.23±2.27^{gD}**	**62.59±0.15^{fA}**	**51.85±0.33^{gC}**	**55.08±0.97^{gB}**	**52.44±2.49^{f}**
B3	**66.73±2.39^{bC}**	**78.63±0.11^{bA}**	**74.15±0.66^{bB}**	**74.20±0.18^{bB}**	**73.43±1.39^{b}**
B4	**63.47±2.97^{cC}**	**75.06±0.07^{cA}**	**69.89±1.09^{cB}**	**68.75±0.22^{cdB}**	**69.29±1.41^{c}**
B5	**63.00±3.10^{cD}**	**74.83±0.27^{cA}**	**65.36±0.62^{eC}**	**67.45±0.54^{deB}**	**67.66±1.50^{c}**
B6	**60.73±1.73^{dD}**	**75.82±0.31^{cA}**	**71.56±0.30^{cB}**	**69.53±0.14^{cC}**	**69.41±1.70^{c}**
B7	**57.50±2.32^{eD}**	**73.71±0.20^{dA}**	**69.67±0.80^{dB}**	**65.77±1.81^{eC}**	**66.66±1.92^{d}**
B8	**54.07±2.11^{fC}**	**71.03±0.40^{eA}**	**62.76±0.45^{fB}**	**63.50±0.46^{fB}**	**62.84±1.87^{e}**
Mean of formulas	**61.07±2.44^{C}**	**75.45±1.60^{A}**	**69.35±2.09^{B}**	**69.06±1.87^{B}**	

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

*L**(Lightness with *L*=100 for lightness, and *L*=zero for darkness), *a** [(chromaticity on a green (-) to red (+)], *b**[(chromaticity on a blue (-) yellow (+)], *c**(color saturation), *h*º(hue angle where 0=red to purple, 90˚ =yellow, 180=blush to green and 270=blue scale.

B1: 100%WF1 (Con. 1) B2: 70% WF2+30% Cacao (Con. 2) B3: 80% WF2+20%P
B4: 75%WF2+25%PSP B5: 70%WF2+30%PSP B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP B8: 70% WF2+30% DPP

Effect of storage period on sensory evaluation of sweet biscuit formulas:

It was evident from the data in Table (9) and that the all characteristics of sensory evaluation decreased with the increase of storage period up to 6 months for all biscuit formulas. All samples of biscuit were accepted and can be consumed within 6 months of production without any changes in characteristics of sensory evaluation. A gradual decrease in overall acceptability of biscuit during storage was reported by **Elahi (1999)** who attributed it to moisture absorption, increase in peroxide value and free fatty acids contents in biscuits.

Table 9. Effect of storage period on sensory evaluation of sweet biscuit formulas (mean±SE).

formulas	**Storage period (month)**				**Mean of period**
	0	**2**	**4**	**6**	
			Appearance		
B1	**9.18±0.23^{aA}**	**7.67±0.55^{aB}**	**7.38±0.53^{bcBC}**	**6.90±0.96^{aC}**	**7.84±0.33^{ab}**
B2	**8.91±0.28^{abA}**	**7.78±0.36^{aB}**	**8.40±0.45^{aA}**	**6.80±0.57^{aC}**	**8.00±0.24^{a}**
B3	**8.00±0.27^{cA}**	**7.40±0.31^{abB}**	**7.60±0.27^{bcAB}**	**6.30±0.80^{abC}**	**7.34±0.24^{abc}**
B4	**7.91±0.37^{cA}**	**7.50±0.27^{aA}**	**7.67±0.47^{abA}**	**6.40±0.86^{abB}**	**7.38±0.27^{abc}**
B5	**8.18±0.35^{bcA}**	**7.70±0.30^{aA}**	**6.90±0.53^{cdB}**	**5.90±0.90^{bcC}**	**7.20±0.30^{bc}**
B6	**8.00±0.27^{cA}**	**7.60±0.31^{aAB}**	**7.20±0.61^{bcdB}**	**5.30±1.01^{cC}**	**7.05±0.34^{c}**
B7	**7.55±0.28^{cA}**	**7.20±0.36^{abA}**	**6.50±0.83^{dB}**	**6.00±0.76^{bcB}**	**6.83±0.30^{c}**
B8	**7.45±0.49^{cA}**	**6.70±0.40^{bB}**	**7.00±0.66^{bcAB}**	**6.00±0.67^{bcC}**	**6.81±0.29^{c}**
Mean of formulas	**8.15±0.13^{A}**	**7.44±0.13^{B}**	**7.32±0.20^{B}**	**6.20±0.28^{C}**	
			Color		
B1	**9.09±0.21^{aA}**	**8.11±0.56^{abB}**	**7.38±0.38^{bcC}**	**6.70±0.87^{abBC}**	**7.87±0.31^{ab}**
B2	**8.64±0.51^{abA}**	**8.56±0.29^{aA}**	**8.40±0.45^{aA}**	**7.40±0.52^{aB}**	**8.25±0.24^{a}**
B3	**8.00±0.27^{bcA}**	**7.80±0.33^{bcA}**	**7.10±0.31^{bcB}**	**6.10±0.78^{bcC}**	**7.27±0.25^{bcd}**
B4	**7.91±0.41^{cA}**	**7.60±0.37^{bcdA}**	**7.56±0.47^{bA}**	**6.40±0.81^{bcB}**	**7.38±0.28^{bcd}**
B5	**7.91±0.39^{cA}**	**7.30±0.56^{cdB}**	**7.10±0.43^{bcB}**	**5.80±0.88^{cC}**	**7.05±0.31^{cd}**
B6	**7.64±0.45^{cA}**	**7.30±0.37^{cdAB}**	**6.80±0.57^{cdB}**	**5.70±0.58^{cC}**	**6.88±0.27^{d}**
B7	**7.64±0.59^{cA}**	**6.90±0.43^{dB}**	**6.30±0.45^{dC}**	**6.30±0.70^{bC}**	**6.80±0.28^{d}**
B8	**7.36±0.70^{cA}**	**6.80±0.53^{dB}**	**6.73±0.49^{cdB}**	**6.00±0.58^{bcC}**	**6.74±0.29^{d}**
Mean of	**8.02±0.17^{A}**	**7.53±0.16^{AB}**	**7.15±0.17^{B}**	**6.30±0.25^{C}**	

formulas					
			Odor		
B1	9.00±0.30^{aA}	8.11±0.20^{aB}	8.13±0.40^{abB}	7.00±0.58^{aC}	8.08±0.23^{a}
B2	8.64±0.45^{aA}	8.00±0.17^{abB}	8.70±0.33^{aA}	6.10±0.81^{bC}	7.88±0.30^{a}
B3	7.50±0.29^{bA}	7.70±0.26^{abcA}	7.40±0.48^{bA}	5.40±0.98^{bB}	7.01±0.31^{bc}
B4	7.27±0.19^{bA}	7.30±0.26^{bcA}	6.44±0.67^{cB}	5.70±0.78^{bC}	6.70±0.27^{c}
B5	7.32±0.29^{bA}	7.60±0.27^{abcA}	6.40±0.67^{cB}	4.30±0.87^{cC}	6.43±0.34^{c}
B6	7.55±0.43^{bA}	7.60±0.16^{abcA}	7.30±0.40^{bA}	5.70±0.91^{bB}	7.05±0.29^{bc}
B7	7.27±0.43^{bA}	7.30±0.26^{bcA}	6.80±0.57^{bcA}	5.50±0.85^{bB}	6.73±0.29^{c}
B8	7.18±0.44^{bA}	7.20±0.42^{cA}	6.36±0.58^{cB}	5.50±1.00^{bC}	6.57±0.33^{c}
Mean of formulas	7.72±0.14^{A}	7.59±0.10^{AB}	7.17±0.20^{B}	5.65±0.30^{C}	

Table (9): Cont.

formulas	Storage period (month)				Mean of period
	0	2	4	6	
			Taste		
B1	8.64±0.20^{aA}	7.56±0.53^{aB}	7.00±0.38^{abcC}	6.20±0.85^{abcD}	7.39±0.31^{a}
B2	8.36±0.39^{abA}	7.78±0.43^{aB}	6.80±0.53^{bcC}	5.10±0.96^{dD}	7.03±0.36^{abc}
B3	7.05±0.60^{cA}	7.20±0.33^{abA}	7.20±0.68^{abA}	5.40±0.98^{cdB}	6.72±0.35^{abc}
B4	7.14±0.55cA	7.00±0.52^{abcA}	6.33±0.47^{cdB}	6.00±0.80^{abcB}	6.64±0.30^{abc}
B5	7.05±0.59^{cA}	6.50±0.56^{bcA}	6.80±0.47^{bcA}	5.70±0.86^{bcdB}	6.52±0.32^{bc}
B6	7.73±0.59^{bcA}	7.10±0.60^{abB}	7.80±0.42^{aA}	6.80±0.73^{aB}	7.37±0.29^{a}
B7	7.36±0.59^{cA}	6.40±0.54^{bcB}	7.00±0.56^{abcA}	6.10±0.92^{abcB}	6.73±0.33^{abc}
B8	7.18±0.60^{cA}	6.20±0.61^{cBC}	5.91±0.65^{dC}	6.50±0.81^{abB}	6.45±0.33^{c}
Mean of formulas	7.56±0.19^{A}	6.95±0.19^{B}	6.85±0.19^{B}	5.98±0.30^{C}	
			Crispy		
B1	8.55±0.16^{aA}	7.00±0.37^{aB}	7.13±0.88^{abcB}	6.00±0.76^{bcC}	7.21±0.32^{a}
B2	7.73±0.49^{bcA}	7.11±0.35^{aB}	6.40±0.76^{dC}	5.50±0.81^{cD}	6.70±0.33^{a}
B3	8.18±0.33^{abA}	7.40±0.31^{aB}	7.70±0.21^{aAB}	6.20±0.79^{abcC}	7.39±0.25^{a}
B4	8.00±0.38^{abcA}	7.00±0.33^{aB}	6.56±0.65^{cdB}	6.50±0.83^{abB}	7.05±0.29^{a}
B5	7.50±0.43^{cA}	6.70±0.42^{aB}	6.40±0.78^{dB}	5.60±0.83^{cC}	6.57±0.32^{a}
B6	7.45±0.41^{cA}	7.00±0.15^{aA}	7.50±0.34^{abA}	6.10±0.82^{abcB}	7.02±0.25^{a}
B7	7.86±0.44^{abcA}	7.20±0.25^{aB}	6.60±0.67^{cdC}	6.40±0.50^{abC}	7.04±0.25^{a}
B8	7.41±0.58^{cA}	6.80±0.33^{aB}	6.55±0.45^{cdB}	6.80±0.47^{aB}	6.89±0.23^{a}
Mean of formulas	7.84±0.15^{A}	7.03±0.11^{B}	6.85±0.21^{B}	6.14±0.25^{C}	
			Overall acceptability		
B1	9.45±0.80^{aA}	8.84±1.79^{abB}	8.70±1.46^{abB}	8.28±3.60^{aC}	8.84±1.28^{a}
B2	9.23±1.85^{abA}	8.92±1.29^{aB}	8.87±1.43^{aB}	8.09±3.04^{abC}	8.78±1.20^{ab}
B3	8.87±1.40^{cA}	8.75±1.00^{abcA}	8.70±1.42^{abcA}	7.94±4.02^{bcB}	8.57±1.23^{ab}
B4	8.82±1.54^{cA}	8.64±1.17^{abcdAB}	8.46±2.19^{cdeB}	8.10±3.99^{abC}	8.51±1.25^{bc}
B5	8.79±1.67^{cA}	8.58±1.47^{bcdAB}	8.36±2.39^{deB}	7.73±4.07^{cC}	8.38±1.39^{c}
B6	8.86±1.82^{cA}	8.66±0.73^{abcdA}	8.66±1.92^{abcdA}	7.96±3.23^{bcB}	8.54±1.14^{abc}
B7	8.77±2.13^{cA}	8.50±1.02^{cdB}	8.22±2.58^{eB}	8.03±3.30^{abcC}	8.41±1.23^{c}
B8	8.66±2.48^{cA}	8.37±1.88^{dB}	8.25±2.30^{eBC}	8.08±3.06^{abC}	8.35±1.23^{c}
Mean of formulas	8.93±0.66^{A}	8.65±0.49^{B}	8.53±0.73^{B}	8.03±1.21^{C}	

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

B1: 100%WF1 (Con. 1) B2: 70% WF2+30% Cacao (Con. 2)
B3: 80% WF2+20%PSP B4: 75%WF2+25%PSP
B5: 70%WF2+30%PSP B6: 80% WF2+20% DPP
B7: 75% WF2+25% DPP B8: 70% WF2+30% DPP

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خصائص جودة البسكويت المضاف إليه تفل بذور الرمان أو المتبقي من كبس التمر

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تهدف هذه الدراسة إلى معرفة تأثير استبدال دقيق القمح بنسبة 20 , 25 و30٪ من مسحوق تفل بذور الرمان أو مسحوق تفل البلح على الخصائص الفيزيائية , الكيميائية والحسية للبسكويت الحلو. وقد أظهرت النتائج المتحصل عليها أن مسحوق كلا من تفل بذور الرمان وتفل البلح سجلت أعلى محتوى للمستخلص الأثيري, الرماد والألياف الخام. من خلال زيادة نسب الإستبدال بالمصدرين السابقين في البسكويت المنتج، بينما لوحظ حدوث انخفاض في محتوي كل من البروتين الخام, الكربوهيدرات والطاقة المتاحة تدريجياً مقارنة بعينة الكنترول. كما أوضحت النتائج المتحصل عليها أن المحتوى الرطوبي والنشاط المائي قد ازدادت معنويا بزيادة نسب الإستبدال بكل من مسحوق تفل بذور الرمان أو تفل البلح. انخفضت قيمة الرقم الهيدروجيني لعينات البسكويت خلال فترة التخزين بشكل كبير عن طريق زيادة نسب الإستبدال بمسحوق تفل بذور الرمان أو مسحوق تفل البلح. كما أظهرت النتائج أن قيمة الرقم الهيدروجيني لجميع عينات البسكويت زادت مع زيادة فترة التخزين حتى 6 أشهر. في الوقت نفسه حدثت زيادة في كل من رقم الحامض ورقم البيروكسيد لعينات البسكويت بشكل ملحوظ مع زيادة فترة التخزين حتى 6 أشهر. أظهرت النتائج التي تم الحصول عليها أن عينة البسكويت حتى نسبة استبدال ٣٠٪ من كل من مسحوق تفل بذور الرمان ومسحوق تفل البلح كانت مقبولة من حيث الخصائص الحسية.

الكلمات الدالة: تفل بذور الرمان، تفل البلح، البسكويت، الخصائص الفيزيائية والكيميائية، تأثير التخزين.