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Utilization of Sugar Beet Pulp to Improve Quality of Flat Bread

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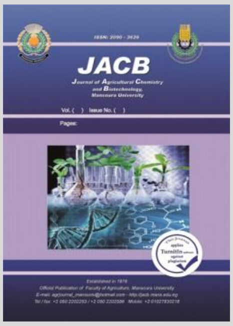

ABSTRACT

The effect of partial replacement of wheat flour (72% extraction) by different levels (3%, 6%, 9%, and 12%) of sugar beet pulp (SBP) on rheological properties of the dough and quality characteristics of the flat bread produced were investigated. The results showed that SBP contained 7.61% moisture, 6.04% ash, 10.50 Crude protein, 17.55% Crude fiber, 0.53% fat, and 57.77% total carbohydrates. The rheological properties (Farinograph and Extensograph) of the dough were tested. The addition of SBP to wheat flour increased water absorption, mixing time, development time, dough weakening, and decreased dough stability. The addition of SBP also caused an increase in dough resistance to extensibility, proportional number, and a decrease in dough extensibility. On the other hand, the results indicated that values A.W.R.C. decreased as storage periods were increased, but the addition of SBP led to increase in the bread's freshness and reduce the decreasing rate during storage periods. Also, the blend of SBP with wheat flour in the bread decreased the acceptance of its sensory properties by the human members. it can be concluded that it is possible to produce acceptable flat bread fortified with up to 6% of SBP. Finally, the addition of SBP to wheat flour improved rheological properties of dough and improved flat bread quality.

Keywords: Sugar beet pulp, Rheological properties, Sensory evaluation, Flat bread

INTRODUCTION

Sugar crops are crops grown for obtaining sugar. There are two main sugar crops: sugar cane (Saccharum officinale L.) and sugar beet (Beta vulgaris L.) which are the main sources of sucrose for human consumption (FAO, 2009). Sugar beet ranks second after sugar cane as a source of sugar. In Egypt, the importance of sugar beet comes not because of its high sugar production, but because of the limited water needs, as it is used as fodder and organic matter in the soil (Abdelaal, 2015). Sugar beet is grown in the temperate regions of the Northern Hemisphere in the North and Middle of Egypt (FAO, 2009). Also, Sugar beet is grown in arid and semi-arid regions (Wahab and Salih, 2012). Sugar beet wastes are by-products, which are parts of sugar beets that do not go through the process of extracting sugar and that are not usable or used as livestock feed (Hutnan *et al*., 2000). Sugar beet pulp (SBP) is the residue after extracting the sugar and it contains hemicellulose, cellulose, proteins, pectin, sucrose, lignin, and fat (Broughton *et al*., 1995). SBP is a valuable and important source of dietary fiber. Also, it is used to produce a concentrated dietary fiber for the food industry (Basman and Koksel, 1999 and Persson, 1986). Dietary fibers have protective physiological effects on humans due to their ability to bind cholesterol and bile and inhibit their resorption. Dietary fibers prevent constipation, protect against cancer, heart disease, and prolong the feeling of satiety. (Higham and Read, 1992; Gallaher and Hassel, 1995 and Kritchevsky, 2001). The dietary fiber of sugar beet is characterized by its low of phytic acid and its high ability to bind and water retention, which is of importance for the bread industry (Graf, 1986 and Stauffer, 1993). Dietary fibers can be widely used in bakery products, pastries, snacks, and meat products. The application of dietary fibers from SBP changes the main characteristics of the quality of bakery products, and bakery products have their freshness for a long time (*Christensen, 1989* and Stauffer, 1993).

The aim of this work is to study the effect of partial replacement of wheat flour (72% extraction) by different levels (3%, 6%, 9%, and 12%) of SBP on the rheological properties and quality of flat bread.

MATERIALS AND METHODS

Preparation of Samples

Sugar beet pulp (Beta vulgaris L.) were collected from Nile Sugar Company, Abu El-Mattamir, El Beheira Governorate, Egypt. SBP was dried for 48 hrs. at 50 oC, ground by a laboratory mill was used to give flour. They were stored at room temperature (25 ± 5 oC) until use.

Chemical Composition:

The chemical composition of SBP was determined according to (Zhao *et al*., 2005) by Near-Infra Red (NIR) Spectroscopy apparatus.

Rheological Properties of Wheat Flour Supplemented with Sugar Beet Pulp

Farinograph Test: -

Farinograph test was carried out to determine water absorption (%), mixing time (min.), development time (min.), stability (min.), and dough weakening (B.U) according to the methods described in the AACC (2002).

Extensograph Test: -

Extensograph test was carried out to determine resistance to extension (BU), extensibility (mm), proportional number, and energy (cm2) according to the method described in AACC (2002).

Dough Preparation and Bread Making: -

Different formulas of flat bread were prepared to study the effect of SBP addition on the characteristics of produced bread Table (1).

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Table 1. Flat bread formulas containing SBP.

Addition level	W F 72 %	SBP %	Yeast	Salt
Control	100	0	1	1
3%	97	3	1	1
6%	94	6	1	1
9%	91	9	1	1
12%	88	12	1	1

W F 72: Wheat Flour (72% extraction), SBP: Sugar Beet Pulp

Flat bread was prepared at the Epics group for food industries Co., October city, Giza, Egypt on an experimental scale according to Abd El – Rahim *et al*., (1999).

The formula used was as follows:

Flour	1000 gm
Active dry yeast	10.0 gm
Salt	10.0 gm
Water (variable)	650 – 700 ml

The dough was made by using the straight dough method by mixing all the ingredients in a mixer for 8 minutes. The temperature of the dough after mixing was 27 ºC. The dough was left to rest at 35 ºC for 15 minutes before divided into pieces (100 gm for each). The dough pieces were shaped by flatting to 20 cm diameter circular. The shape dough was left 45 minutes for final proof. Baking was done at 450 – 500 ºC for 1.0 min.

Determination of Staling Rate: -

The staling rate of bread at different storage period 0, 24, 36 and 72 hours at room temperature, was tested by the determination of Alkaline Water Retention Capacity (A.W.R.C), according to the method of Kitterman and Rubenthaler (1971).

Sensory Evaluation: -

The prepared flat bread was sensory evaluated for its taste, odor, crust color, crumb color, stickiness and layer separation. The evaluation was carried out, according to the method of Faridi and Rubenthaler (1984). Sensory characteristics were carried out by ten panelists from the staff of the Food Technology Research Institute, Agric. Res. Center.

Statistical Analyses: -

All data of sensory evaluation were carried out and statistically analyzed using one–way analyses of variance, ANOVA according to (Steel and Torri, 1980).

RESULTS AND DISCUSSION

Chemical Composition of SBP: -

The results presented in Table (2) noticed that approximate chemical composition of SBP contained, 7.61% moisture, 6.04% ash,10.50 Crude protein,17.55% Crude fiber, 0.53% fat, and 57.77% total carbohydrates. These results showed that SBP is rich in total carbohydrates and an important source of crude fiber, which can be widely used to produce a concentrated dietary fibers for the food industry and flat bread industry. These results agree with Pińkowska *et al*., (2019). Also, Essa and Mostafa (2018) reported that the chemical composition of SBP powder contained ash, moisture, fat, protein, fiber and carbohydrates which were 4.80, 6.30, 0.66, 9.86, 21.98 and 62.70%, respectively.

Table 2. Chemical composition of SBP.

Chemical Composition	SBP
Moisture (%)	7.61
Ash (%)	6.04
Crude Protein (%)	10.50
Crude Fiber (%)	17.55
Fat (%)	0.53
*Total Carbohydrate (%)	57.77

***Total carbohydrates were calculated by difference**

Rheological Properties of Wheat Flour Supplemented with SBP

Farinograph Properties: -

The effect of partial replacement wheat flour by different levels of sugar beet pulp at 3, 6, 9, and 12% on farinograph properties is presented in Table (3). The results indicated an increase in water absorption compared with control by increasing the levels of SBP. Water absorption started with 58% and reached to 72% after the addition of 12% of SBP. This means that the rate of water absorption increased with increasing SBP levels. The increased water absorption, according to the addition of the SBP may be due to its appetite for water absorption. The same Table showed that the addition of SBP to the dough increased the mixing time and development time, which started with 0.5 and 1 min at control to 4 and 5 min, respectively at 12% SBP. These increases may be because the fibers take a longer time to absorb the water, in other words, the fibers need more time to absorb water. Increasing SBP levels in dough led to a decrease in the dough stability time, because the fibers work to cut the gluten network, and the increase of SBP increases water absorption and thus leads to weak stability of the dough. According to the dough weakening resulted given in Table (3), the addition of SBP at different levels resulted in an increase in the dough weakening. The highest increase was observed at 12% level for SBP which reached 130 B.U., while it was 80 B.U. for the control. The increment in the dough weakening may be due to the small amount of gluten in the blends. These results agreed with Shoeb (2007) and Rosell *et al*. (2010).

Table 3. Farinograph parameters of wheat flour dough supplemented by different levels of SBP.

SBP %	Water absorption (%)	Mixing Time (min)	Development time (min)	Stability (min)	Dough weakening (B.U)
Control	58.0	0.5	1.0	7.0	80
3 %	60.5	1.0	2.0	6.0	90
6 %	65.0	2.5	3.5	5.0	105
9 %	68.0	3.0	4.5	4.0	115
12 %	72.0	4.0	5.0	3.0	130

Extensograph Properties: -

Data in Table (4) showed the effect of partial replacement wheat flour by different levels of SBP at levels of 3, 6, 9, and 12% on the extensograph properties. The results indicated that the addition of SBP increased the dough resistance to extensibility compared with control. Values of resistance to extension were, 840 and 980 B.U. when adding SBP at levels of 3 and 12%, respectively compared to 720 B.U. for control. On the other hand, the addition of SBP decreased dough extensibility from 210 mm at control to 110, 90, and 80 mm for 6, 9, and 12% SBP, respectively. These results mean that the sugar beet pulp has an oxidizing effect on the dough bonds and gives an effect on the formation of the gluten network. Concerning proportional number, the results indicated an increase in proportional number with increasing the levels of SBP which can be related to the increase of resistance to extension and the decrease in extensibility. On the contrary, the dough energy decreased with increasing the levels of SBP (Table 4). These results are in line with (Soronja-Simović *et al*., 2016).

Table 4. Extensograph parameters of wheat flour dough supplemented by different levels of SBP.

SBP %	Resistance to extension (R) (B.U)	Extensibility (E) (mm)	Proportional number R/E	Energy (cm^2)
Control	720	210	3.43	177.05
3 %	840	140	6.0	125
6 %	910	110	8.27	105
9 %	940	90	10.4	90
12 %	980	80	12.3	75

Staling Rate Evaluation:

Alkaline water retention capacity (A.W.R.C.) is a good test for evaluating the staling rate during storage. Higher values of A.W.R.C mean more freshness of produced bread. Data in Table (5) showed that the effect of the addition of SBP on the freshness of flat bread, which was stored at room temperature for 24, 36, and 72 h. The results indicated that A.W.R.C. decreased as storage periods were increased. After 24 hrs. the freshness of bread decreased (as decreasing rate%) by 9.7, 6.5, 5.6 and 3.4 % for 3, 6, 9 and 12% SBP, respectively, compared to 14.6% for control. The same trend was observed with 36 and 72 hours of storage. The flat bread sample containing 12% SBP had the highest values of A.W.R.C. which were decreased during 24, 36, and 72 hrs of storage to 287, 277, and 265%, respectively. That flat bread also had the lowest values of decreasing rate during storage periods being 3.4, 6.7 and 10.8 at 24, 36 and 72 hours of storage, respectively, followed by that flat bread containing 9, 6, 3% SBP and finally control sample. The results showed that with increased storage time, the freshness decreases, but the addition of sugar beet pulp (SBP) to the bread increases the bread's freshness and this may be due to the absorption of water by the SBP, which maintains the rate of freshness. These results are consistent with (El-Adly and El-Gendy, 2009)

Table 5. Alkaline water retention capacity of produced flat bread during storage (%).

Treatments / Times	Zero time	24 hr.	Decreasing rate%	36 hr.	Decreasing rate%	72 hr.	Decreasing rate%
Control	280	239	14.6	221	21.1	213	23.9
3 %SBP	277	250	9.7	237	14.4	228	17.7
6 % SBP	276	258	6.5	245	11.2	238	13.8
9 % SBP	286	270	5.6	262	8.4	249	12.9
12 % SBP	297	287	3.4	277	6.7	265	10.8

Sensory Evaluation: -

Table (6) showed the effect of the added SBP on all sensory properties in flat bread. The results revealed that there are non-significant differences in all bread sensory properties between the control and (3%, 6% of SBP), but there are significant differences between the control and (9%, 12% of SBP). The highest total score observed in the control sample, while the lowest was at 12% SBP. The results indicated that the increasing levels of SBP led to a decrease in scores of sensory properties (taste, odor, crust, color, crumb color, stickiness) and an increase in layer separation compared to the control (Figure 1). Values of total scores of sensory were 93.5, 88.5, 79.5, and 69 % for bread produce with 3, 6, 9, and 12% SBP, respectively compared to 94% for the control. These may be due to the action of SBP fiber on the dough network which acts as a break downing the bonds in gluten. From these results in Table (6), it can be concluded that it is possible to produce acceptable flat bread fortified with up to 6% of sugar beet pulp. These findings were consistent with Sudha, *et al*., (2007).

Table 6. Sensory evaluation of flat bread containing SBP.

	Taste	Odor	Crust color	Crumb color	Stickiness	Layer separation	*Total Scores*
Scores	20	20	15	15	15	15	100
Control	19	19.5	14.5	14	14	13	94
3% SBP	19	19	13.5	14	13.5	14.5	93.5
6% SBP	17	18	13.5	13.5	12.5	14	88.5
9% SBP	14	16	12	12	12	13.5	79.5
12% SBP	12	13	9	10	11.5	13.5	69
L.S.D 5%	2.09	1.67	1.38	1.54	1.80	0.24	5.63

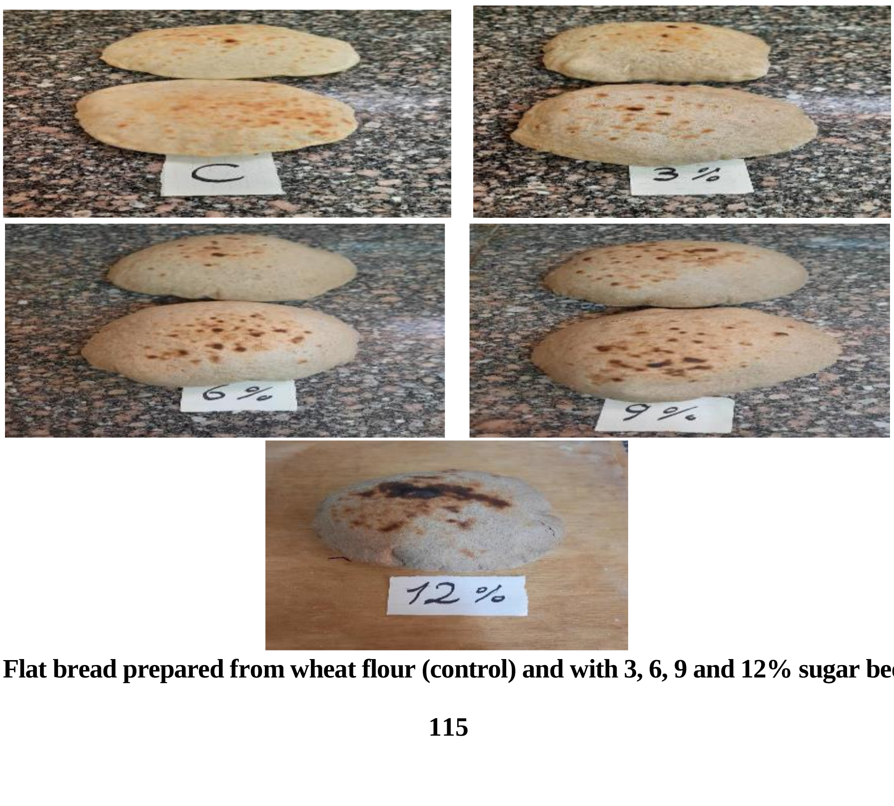

Fig. 1. Flat bread prepared from wheat flour (control) and with 3, 6, 9 and 12% sugar beet pulp

CONCLUSION

It can be concluded that SBP is a good source of carbohydrates and fibers. The addition of SBP to wheat flour led to the increase of water absorption, mixing time, development time, dough weakening, and the decreases of dough stability. In addition to, increasing in dough resistance to extensibility, proportional number, and decreasing in dough extensibility. The incorporation of wheat flour with SBP increases the bread's freshness and reduces the decreasing rate during storage periods. Finally, the use of low-cost dietary fiber sources should be encouraged.

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استخدام لب بنجر السكر لتحسين جودة الخبز المسطح

أحمد السيد خطاب [١]، هيثم أحمد زكي الخميسي[١]، صبري محمد علام محمد [٢] و كريم يوسف محمد يوسف[٢]

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تم إجراء هذا البحث لدراسة تأثير الاستبدال الجزئي لدقيق القمح (استخلاص ٧٢٪) بمستويات مختلفة بنسب (٣٪، ٦٪، ٩٪، ١٢٪) من لب بنجر السكر على الخصائص الريولوجية لخلطات العجين وخصائص جودة الخبز المسطح المنتج. أظهرت النتائج أن لب بنجر السكر احتوى على ٧,٦١٪ رطوبة، ٦,٠٤٪ رماد، ١٠,٥٠ بروتين خام، ١٧,٥٥٪ ألياف خام، ٠,٥٣٪ دهون، ٥٧,٧٧٪ الكربوهيدرات الكلية. تم اختبار الخصائص الريولوجية بواسطة جهازى الفارينوجراف والاكستنسوجراف لخلطات العجين مع مقارنته بدقيق القمح استخلاص 72 %. اظهرت النتائج المتحصل عليها من جهاز الفارينوجراف ان إضافة لب بنجر السكر إلى دقيق القمح أدى إلى زيادة نسبة امتصاص الماء، وزمن العجن، وزمن تطور العجين، وضعف العجين، وانخفض زمن ثبات العجين. أيضا، أظهرت النتائج المتحصل عليها من جهاز الاكستنسوجراف زيادة مرونة العجين والرقم النسبي مع انخفاض المطاطية. من ناحية أخرى، أشارت النتائج أن قيم اختبار القدرة على الاحتفاظ بالماء (البيات) انخفضت مع زيادة فترات التخزين، لكن إضافة لب بنجر السكر للخبز زادت من طزاجة الخبز وخفضت من معدل التناقص أثناء فترات التخزين. كما أن خلط الخبز بمستويات مختلفة من لب بنجر السكر خفض من قبول خصائصه الحسية وكانت أفضل النتائج المتحصل عليها لإنتاج خبز مسطح مقبول عند مستوى اضافة ٦ ٪ من لب بنجر السكر. أخيرًا، أدت إضافة لب بنجر السكر إلى دقيق القمح إلى تحسين الخصائص الريولوجية وتحسين جودة الخبز المسطح.