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UTILIZATION OF SUGAR-BEET FIBERS IN PAN BREAD PRODUCTION

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ABSTRACT

The application of fibers from various sources in food production is increasing due to their beneficial effects on human health. The aim of this work is to investigate the effects of non-modified and modified sugar-beet fibers on dough and bread characteristics. Dry sugar-beet fibers were ground, sieved (>95 µm), hydrated for 24 hr and pressed for removing excess water. A portion of hydrated fibers was exposed to a further treatment with H2O2 additional 24 hr. Treated fibers were neutralized, washed with tap and distilled water, pressed and blended to a homogenous mass with fine particles to obtain modified fibers. Dough and bread were made from wheat flour 72% extraction rate, salt, sugar, oil and yeast (as it is used in regular pan bread production), without fiber, with non-modified fibers and with modified fibers. Experiments were planned so that the quantity of the applied fibers in the blends varied from zero% to 15% controlling characteristics of the product were: yield of dough and bread volume, crumb quality, sensory evaluation of bread and staling rate of bread. The results indicated that the replacement of sugar-beet fibers until 5% non-modified and 10% modified produced pan bread with acceptable sensory properties while it was found that the most effective replacement percent of sugar beet fibers for retarding the staling to modified and non-modified sugar beet fibers was 15%.

Key words: Pan bread – Sugar-beet fibers – Anti-staling.

INTRODUCTION

Products enriched with fibers from various sources can be considered as functional foods, satisfying claims (Berghofer 2000), particularly when made of natural substances and when consumed every day. Such products contribute to specific metabolic pathways in an organism (Guillon *et al.,* 1998; and Wang *et al.,* 2002). Food containing high fibers causes hunger alleviating effect and, at the same time, dose not cause binding minerals like calcium, magnesium and zinc (Stauffer, 1993; Westenhoefer, 2001).

The recommendations for dietary fibers intake range from 25 to 30g day^{-1} (Asp, 2004, USDA, 2002). On the other hand, bakery products, particularly bread, take a significant share in the food guide pyramid for daily food choices recommended by US Department of Health and Human Services (2004). Therefore, the development of enriched bread with higher fibers content is one of the efficient ways to increase the fibers intake (Goesaert *et al.,* 2005; Sangnark & Noomhorm, 2004; Wang *et al.,* 2002). The main source of fibrous materials, which can be incorporated into bakery products, is cereal bran, particularly wheat bran (Lai *et al.,* 1989; Ranhotra *et al.,* 1990; Sidhu *et al.,* 1999) and also rice bran (Abdul-Hamid & Siew Luan, 2000). However, bran has a low water retention capacity and is adversely affecting crumb colour. So, investigations need to be directed toward other possible sources, including sugar-beet.

In sugar-beet technology, pulp is remaining after sugar extraction as a waste product. Favorable sensory, physical and chemical characteristics, as well as microbiology, qualify this material as a valuable source of dietary fibers (Basman & Koksel, 1999; Persson, 1986). In comparison with cereal bran, sugar-beet fibers are characterized by (i) low phytate, which is of particular concern to nutritionists because of its possible adverse effects on mineral absorption (Graf, 1986) and (ii) better water binding and retention capacity, which is of particular interest for the baking industry (Stauffer, 1993). A wide range of research activities is related with the adjustment of fibers characteristics, by grinding (Auffret *et al.,* 1994), by chemical treatment (Jasberg *et al.,* 1989; Renard *et al.,* 1994) and by other methods. Adjustments are undertaken in order to meet consumer's preferences for white or light coloured bread.

The aim of this investigation is to utilize the optimal quality and quantity of sugar-beet fibers, production of in pan bread as atrial to improve yield of dough, yield of bread, bread volume and crumb quality.

MATERIALS AND METHODS

Materials:

Sugar-beet cossettes, safe product concerning heavy metals and microbiology as recommended by Gyura *et al.,* (2003), were obtained from Delta company to produce sugar of Kafer El-Shekh.

Wheat flour 72% extraction (ash and protein content 0.54 and 11.4% d.m. basis, respectively), determined according to A.O.A.C. (1996) oil, sugar, salt and yeast were of commercial grade, as it is used in pan bread production were obtained from the local market, Giza, Egypt.

Methods:

Preparation of Non-modified fibers:

The fibers was treated after 60 min extraction of sugar-beet cossettes with sulphurous acid at 75˚C and pH= 5.7 are considered to be non-modified fibers. After drying at 80˚C fibers were ground in laboratory mill, type 3100, sieved through a laboratory sieve and a fraction with partices less than 95 µm were used for further treatment prior dough mixing. These types of fibers were hydrated for 24 hr. (ratio fibers to water 1 : 4) at room temperature.

Preparation of Modified fibers:

Prior to grinding non-modified fibers were hydrated for 24 h (ratio fibers to water= 1: 9) at room temp.; then pressed in a laboratory press to remove excess water. After pressing the fibers were treated with H2O2 10% (1 : 50 w/v) . The pH was adjusted to 11 with 10 M NaOH.

After (24h) of chemical treatment, (alkaline pH = 11) fiber were neutralized with HCl until the pH reached the value 6- 7 in all cases. Chlorine ions were washed with tap and distilled water to reach negative reaction to Cl^- ions. Modified fibers were pressed to remove the excess water and blended to a homogenous mass with fine particles in a Braun blender.

Baking procedure:

Pan bread was baked according to the AACC method (1995). Dough constituents were: flour (100- 85%). Sugar-beet fibers (0- 15%), salt (2%),

yeast (1.5%), oil (5%) and (5%) sugar were placed in the mixer and then mixed with water until optimum consistency was obtained. The dough was removed from the mixer and rounded, molded and put in panneel (5x9x8 cm) tightly greased pan to prevent the sticking of resulted bread. Fermentation process was carried out for 90 min. at 30 oC and 85% relative humidity after proofing bread was baked approximately 15 min in a Chopin laboratory oven at 260˚C. The quality of bread was characterized by whight dough, bread volume, bread yield and whight of ban bread.

Analytical methods:

Chemical composition (dry matter, proteins, mineral matters) of fibers were determined according methods described by Filipovic *et al.* (2007).

Water holding capacity of dietary fibers was determined according to Stauffer (1993) as follow: 2.5 g of dried ground fibers were suspended in distilled water 30 ml at 30˚C in a centrifuge glass tube 50 Cm^3 and thermo-stated for 30 min at 30˚C. The suspension was centrifuged at 5000 xg for 5 min and the swollen fibers particles were separated from the supernatant and weighed. The water holding capacity of the fibers was calculated by the difference between the hydrated (swollen) and dried sample.

Fibers determination:

Soluble and non-soluble fibers were determined according to the methods outlined in A.O.A.C. (1996).

Determination of staling:

Moisture, alkaline retention capacity as an indicater for staling was carried out according to the methods of Mohamed (2000). As an indicators for staling of pan bread.

Sensory evaluation

Sensory evaluation of Pan bread was carried out according to the method of Fairdi and Rulenthaler (1984).

RESULTS AND DISCUSSION

Data presented in Table (1) and Fig. (1) reveal that the fibers modified by hydrogen peroxide contributes to highly increase in water holding capacity and favorable ratio of soluble to insoluble fibers.

Treatment by hydrogen peroxide diminished fibers off colour as illustrated in Fig. (2). These results are in agreement with those obtained by Thibault (1994).

Data in Table (2) show that water adsorption of dough, weight of dough, bread volume, bread yield and weight of pan bread were increased with the increasing of fibers quantity (modified and non-modified), while at same time the quality of pan bread decreased with the increasing of fibers quantity. These results are in agreement with those obtained by Stauffer (1993).

Measurement of freshness of pan bread containing sugar-beet fibers (modified and non-modified):

Bread staling is generally considered to involve several phenomena. Among these are (1) moisture redistribution among bread component. (2) The crystallization of various starch fractions (3) the loss of volatile

constituents related to flavor and (4) variation in the structure from helix to coil and shortening of the chain. Data in Table (3) show the effect of sugar-beet fibers on crumb extensibility and strength of stored pan bread. From these results, it could be noticed that the moisture of pan bread was decreased during storage but the rate of this decrease was lowered by addition of 5, 10 and 15% sugar-beet fibers (modified and non-modified).

The same trend was found on alkaline water retention capacity in Table (4). These results are in agreed with those reported by Stauffer (1993).

Effect of sugar-beet fibers replacement on sensory quality of pan bread:

Sensory properties, including crust color, crumb color, texture, taste and odor of pan bread prepared from blending wheat flour (72% extraction grade) with sugar-beet fibers replacement at 5,10, and 15% (modified and non-modified) are presented in Table (5). It is clear that replacement of 15% sugar-beet fibers (modified and non-modified) improved the texture, while crust and crumb colors were acceptable until 10% of modified sugar-beet fiber and 5% of non-modified one comparing with control and other blends at zero time, and the same trend was also observed after 24 and 48 hrs of the storage.

Generally, this replacement resulted in an improvement in bread texture beside its effect on retarding the staling rate. These results go parallel with those of Basman and Koksel (1999).

From the obtained data it could be recommended that using sugar beet fiber as replacement of flour give low calorie. Also, the ingestion of sugar beet fiber induces mucosal enlargement. The mucosa cell growth may be involved in water and ion transport and also in development of colon cancer. Sugar beet fiber fermentation in the large intestine is related to the mucosal cell growth. Also, short-chain fatty acids (SCFAs) produced by cecal fermentation of sugar beet fiber are absorbed and used as an energy source of cells and induce mucosal cell proliferation Hiroshi Hara *et al.* (1996).

Table (1): Chemical composition of modified and non-modified sugar-beet fibers.

Parameters	Modified fibers	non-modified fibers
Dry matter content (%)	91.6	97.4
Water holding capacity (%)	898	610
Total fibers % d.m. basis	94.22	70.21
Insoluble fibers % d.m. basis	61.13	55.91
Soluble fibers % d.m. basis	13.32	12.31
Proteins % d.m. basis	14.18	12.41
Ash content %	2.33	2.42

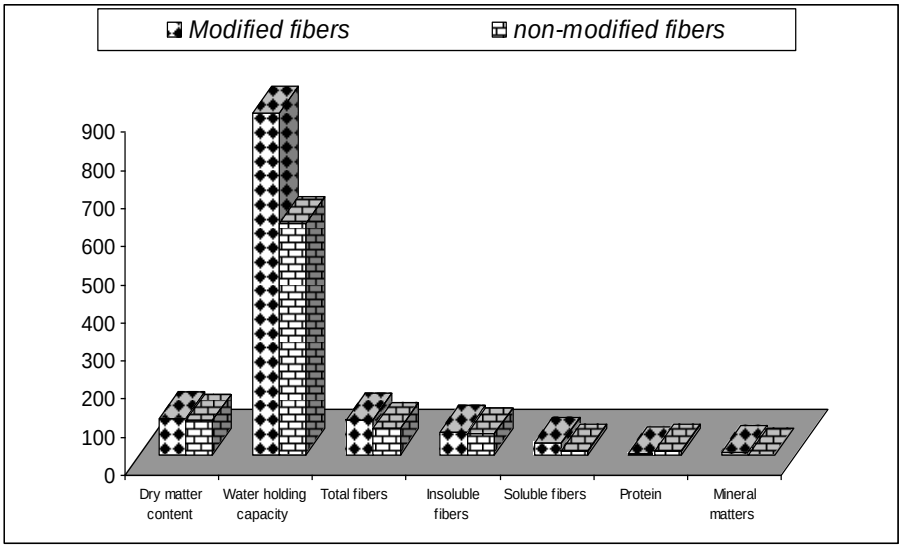


Fig. (1): Chemical composition of modified and non-modified sugar-beet fibers.

Table (2): Physical properties of pan bread containing different levels of modified and non-modified sugar-beet fibers.

Properties / Treatments	Water absorption of dough (mL)	Weight of dough (g)	Bread/ volume (gm/Cm3)	Bread yield (mL)	Weight of pan bread (g)
1	125	230.10	825	4.0	214.67
2	150	240.00	855	4.5	221.78
3	175	255.66	875	4.9	241.92
4	200	287.87	875	5.5	271.48
5	150	238.72	915	5.0	229.98
6	175	271.85	920	5.5	254.80
7	200	282.00	930	6.0	265.01

- Sample number (1) control.
- Sample from (2 to 4) made with sugar-beet fiber modified.
- Sample from (5 to 7) made with sugar-beet fiber non-modified.

Table (3): Moisture content of pan bread containing different levels of modified and non-modified sugar-beet fibers as indicator of crumb extensibility and strength

Times / Treatments	Zero time	24 hours	48 hours	Percentages of decrease(%)
1	35.51	31.07	26.93	24.16
2	37.17	33.92	29.67	20.17
3	39.91	36.02	33.61	15.78
4	40.57	37.93	35.05	13.60
5	37.12	33.85	29.62	20.20
6	39.42	36.56	33.77	14.33
7	40.41	37.86	35.31	12.62

- Sample number (1) control.
- Sample from (2 to 4) made with sugar-beet fiber modified.
- Sample from (5 to 7) made with sugar-beet fiber non-modified.

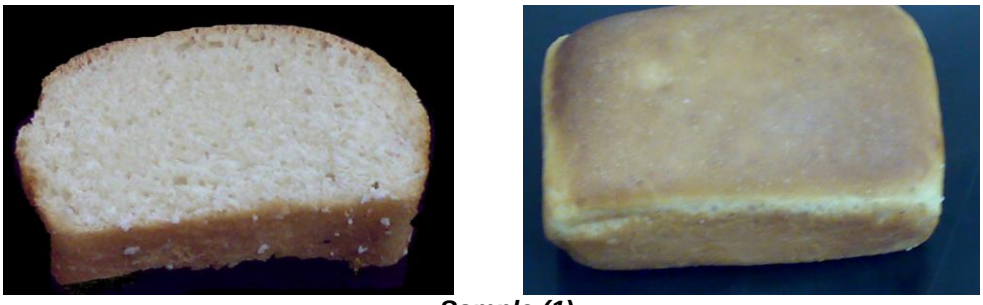
Table (4): Effect of modified and non-modified sugar-beet fibers on alkaline water retention capacity of produced pan bread after zero time, 24 and 48 hr.

Times / *Treatments	Zero time	24 hours	48 hours	Percentages of decrease(%) after 48 hrs.
1	190.47	147.93	116.64	49.90
2	210.00	187.61	168.33	19.84
3	222.65	202.38	187.88	15.61
4	252.77	237.60	223.02	11.76
5	204.71	171.68	147.85	27.77
6	222.00	200.63	183.27	17.44
7	231.62	210.68	198.73	14.23

Table (5): Effect of modified and non-modified sugar beet fibers as substitute of wheat flour on sensory score of pan bread.

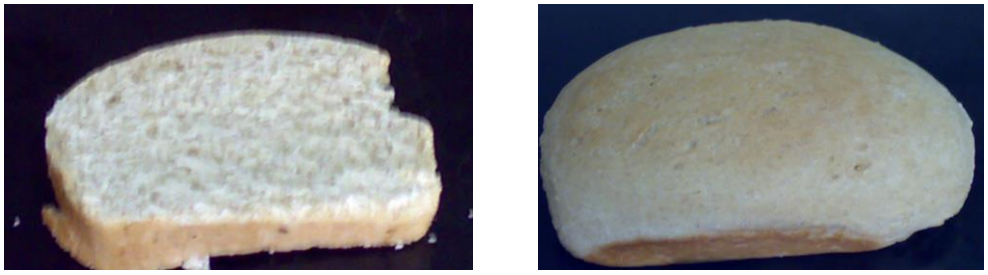
Number of sample	Level of sugar-beet fiber substitute	Properties					
		Crust color	Crumb color	Texture	Tast	Oder	Overall acceptability
1	0	9.5	9.5	7.0	9.5	9.0	44.5
2	5	9.0	9.0	8.0	9.0	9.0	44.0
3	10	8.0	8.0	9.0	8.0	8.5	41.5
4	15	7.0	7.0	9.5	7.0	7.5	38.0
5	5	7.0	7.0	8.0	7.0	7.0	36.0
6	10	6.0	6.0	9.0	6.0	6.0	33.0
7	15	5.0	5.0	9.5	5.0	5.0	29.5
L.S.D at 5%		0.33	0.33	0.12	0.33	0.24	4.25

- Sample number (1) control.
- Sample from (2 to 4) made with sugar-beet fiber modified.
- Sample from (5 to 7) made with sugar-beet fiber non-modified.



Sample (1)

Sample (2)



Sample (3)

Sample (4)

Sample (5)

Sample (6)

Sample (7)

Fig. (2): Effect of substituted modified and non-modified sugar-beet fibers on pan bread.

- Sample number (1) control.
- Sample from (2 to 4) made with sugar-beet fiber modified.
- Sample from (5 to 7) made with sugar-beet fiber non-modified.

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استخدام الياف بنجر السكر في صناعة خبز القوالب

نبيل عبد الفتاح العدلي و أسمة أحمد الجندي

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أن الاستخدام التطبيقي للألياف من مصادر مختلفة في إنتاج الأغذية يتزايد ويرجع ذلك إلي التأثيرات المفيدة للألياف علي صحة الأنسان.

والهدف من هذا البحث هو عرض التأثيرات لألياف بنجر السكر المعدله والغير معدله علي العجينة ومحصول الخبز وحجم الرغيف والتقييم الحسي للخبز ومعدل البيات في خبز القوالب. الياف بنجر السكر المجففة تم طحنها ونخلها خلال منخل معملي وتجزئتها إلي أجزاء صغيرة أقل من ٩٥ نانوميتر وذلك لأستخدامها في المعاملات التالية. تم وضعها في الماء لمدة ٢٤ ساعة وضغطت لأزالة الماء الزائد وبطريقة مماثلة تم الحصول علي الياف بنجر معاملة بالماء غير معدله. جزء من الألياف الغير معدله تم أستخدامها لمعاملة تالية مع فوق أكسيد الهيدروجين المضاف لها لمدة ٢٤ ساعة وتم غسلها بالماء المقطر وضغطها وتم خلطها لكي يحدث لها تجنيس والحصول علي قطع متجانسة مع أجزاء ناعمة. وتم أعداد العجين والخبز من دقيق القمح أستخراج ٧٢٪ والملح والخميرة والسكر والزيت لانتاج خبز القوالب بالطريقة المعتادة بدون أضافة الألياف ومع الياف البنجر المعدله والغير معدله.تم أستخدامها سؤاء كانت الياف معدله أو غير معدله في هذه الخلطات بنسب مختلفة من صفر - 15٪ والخصائص التي تم قياسها في المنتج كانت محصول العجينة والخبز والحجم وجودة اللبابة والصفات الحسية ومعدل لبيات للخبز الناتج.

وقد أوضحت النتائج المتحصل عليها أن عملية الأستبدال كان مقبولا بالنسبة للصفات الحسية حتي ٥٪ الياف بنجر السكر الغير مبيضه و ١٠٪ الياف بنجر السكر المبيضه للخبز الأفرانجي الناتج. وكانت أحسن نسبة للأستبدال هي ١٥٪ تأخيرا لعملية التجلد في الخبز الأفرانجي الناتج لكل من الياف بنجر السكر المبيضه والغير مبيضه.