

EFFECT OF ADDING CARROT POWDER ON THE RHEOLOGICAL AND SENSORY PROPERTIES OF PAN BREAD

Hussein, M. A. *; A. A. M. Yonis ** and H. A. Abd El - Mageed **

*** Food indust., Dept., Fac. of Agric., Mansoura Univ. Egypt**

**** Home Economics Dept., Fac., of Specific Education Mansoura Univ. Egypt**

ABSTRACT

The objective of this study was to determine chemical composition and hydration properties of dietary fiber rich carrot powder (CP). The impact supplementation of CP at different levels (replacing of fine wheat flour with 2, 4, 6 and 8% of CP) on rheological properties of wheat dough and qualitative and sensory characteristics of pan bread were also evaluated. CP was found as good source of total dietary fiber and showed high values of hydration properties. Incorporation CP to wheat dough influences farinographic characteristics (increasing of water absorption, dough development time and dough stability, decreasing of mixing tolerance index) of dough and qualitative parameters of final products from the sensory evaluation resulted that loaves incorporated with CP up to 4% were the most acceptable for assessors.

Keywords: Carrot powder, Dough, Rheological properties, Pan bread.

INTRODUCTION

Bread may be described as a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of process involving mixing, kneading, proofing, shaping and baking (*Dewettinck et al., 2008*). Recently, consumer's awareness of the need to eat high quality and healthy foods-known as functional foods which contain ingredients that provide additional health benefits beyond the basic nutritional requirements is increasing (*Ndife and Abbo, 2009*). Therefore, the trend is to produce specially breads made from whole grain flour and other functional ingredients known as health breads or functional foods (*Dewettinck et al., 2008*). Bread can be enriched with dietary fiber (DF) from various sources, namely carrot powder (*Zlatica et al., 2012*). Addition of DF to bakery products increases DF intake, decreases the caloric density of wheat rolls and prolongs freshness due to its capacity to retain water and thus reduces economic losses (*Elleuch et al., 2011, Kohajdova et al., 2011*). Incorporation of fiber into wheat flour interacts directly with structural elements of the three dimension gluten networks and disrupts the starch gluten matrix, and finally affects the rheological behavior of blended dough during mixing, fermentation, and baking. However, the addition of these fibers sometime causes a negative effect on the final bread quality. The most notable change is the reduction of loaf volume (*Lai et al., 1989*), and poor sensory characteristics (*Mis et al., 2012*). Nutritional quality of food supplements based on carrot powder and grits have been reported to be good source of β -carotene, fiber and many essential micronutrients and functional ingredients (*Singh and Kulshrestha,*

2008). The presence of high concentrations of carotenoids, especially β -carotene in carrot roots makes them to inhibit free radical scavengers, anti-mutagenic and immune-enhancers. Carrot is also an excellent source of calcium pectate; an extraordinary pectin fiber that has the cholesterol lowering properties. It has a property to reduce the risk of high blood pressure, stroke, heart disease and some type of cancer (*Bakhra, 1993*). Carrot being perishable and seasonal, it is not possible to readily make it available throughout the year. Dehydration of carrot during the main growing season is one of the important alternatives of preservation to further develop value added products throughout the year (*Krishan et al., 2012*).

In general, vegetables contain a higher soluble DF content, present a better insoluble/soluble DF ratio, and also have better functional properties than those obtained from cereal processing (*Gonzalez-Centeno et al., 2010*). Moreover, these vegetable inexpensive and available in large quantities (*Chantaro et al., 2008, Shyamala and Jamuna, 2010*), exhibit a lower caloric content, and, often, include other interesting compounds such as antioxidants (*Chantaro et al., 2008*) which might provide additional health benefits (*Gonzalez-Centeno et al., 2010*).

The objective of this study was to evaluate the effect of supplementation pan bread with various levels of carrot powder on chemical, rheological, and sensory properties.

MATERIALS AND METHODS

Materials:

Wheat flour (72 % extraction) was obtained from El-Kosar Milling Company. El-Salam city – Cairo, other ingredients such fresh carrots (*Daucus carota*), yeast and salt were obtained from local market.

Methods:

Preparation of pan bread:

72 % extraction wheat flour partially fortified with carrot powder (CP) was used to make pan bread as indicated in the following table (A).

Table (A): Blends of 72 % ext. wheat flour fortified with (CP).

Blends	Blends composition
Control	100 % wheat flour 72 % ext.
1	98 % wheat flour 72 % ext. + 2 % CP
2	96 % wheat flour 72 % ext. + 4 % CP
3	94 % wheat flour 72 % ext. + 6 % CP
4	92 % wheat flour 72 % ext. + 8 % CP

Chemical analysis:

Crude protein, cured fat, ash, and fiber were determined according to the methods of A.O.A.C (2000). Carbohydrate was calculated by difference.

Total carbohydrates = 100 — (moisture + protein + fat + ash)

Total calories were calculated using the equation

E = 4(Carbohydrate + protein) + 9 fat

Where: E = Energy as calories per 100 grams sample

Rheological Properties:-The characteristics of dough were measured by Farinograph according to A.A.C.C (2000). Using a farinograph type (877563 Brabender-Farinograph West-Germany HZ 50). The parameters determined were: water absorption (WA) or percentage of water required to yield dough consistency of 500 BU (Brabender Units), dough development time (DDT, time to reach maximum consistency in minutes), dough stability (DS, time dough consistency remains at 500 BU), mixing tolerance index (MTI, consistency difference between height at peak and that 5 min later).

Baking Technology of Pan Bread:

The straight dough process for pan bread production was carried out according to the method of Kent-Jones and Amos (1967).

Physical Analysis for Pan Bread:

The volume of different types of the produced pan bread was determined by rape seeds displacement method A.A.C.C., (1983).

Specific volume was calculated according to the method of A.A.C.C. (1983) using the following equation:

$$\text{Specific volume} = \frac{\text{Volume (cm}^3\text{)}}{\text{Weight (g)}}$$

Sensory Evaluation of Pan Bread

Pan bread was evaluated for sensory characteristics by ten panelists from the staff members of bread and pastry Res. Dept. Agri. Res. Center, Giza, Egypt. The scoring scheme was established as mentioned by Watts et al., (1989).

Statistical Analysis:

The original sensory panel data and other results were statistically analyzed using analysis of variance (ANOVA) and least significance difference (LSD) at a significance of probability 5 %.

RESULTS AND DISCUSSION

Gross Chemical Composition:

Chemical composition of wheat flour (72 % extraction) and carrot powder (CP) is presented in Table (1). The results indicate that crude protein, total carbohydrates, fat, ash, and crude fiber of 72 % ext. wheat flour were: 11.57, 86.24, 0.89, 0.54 and 0.78 %, respectively. These data are in the same line with those obtained by Doweidar, (2002). Regarding to the same table, the crude protein, total carbohydrates, fat, ash, crude and fiber of dry carrot were 9.2, 65.26, 2.9, 6.83 and 7.16% respectively.

Table (1): Gross chemical composition of wheat flour (72 % ext.) and dry carrot powder(On dry weight basis).

Raw materials	Crude Protein %	Total carbohydrate%	Fat %	Ash %	Crude Fiber %
Wheat flour	11.57	86.24	0.89	0.54	0.78
CP	9.20	65.26	2.90	6.83	7.16

These results are agreement with those obtained by Gopulan et al., (1991). The chemical changes in baked pan bread as influenced by different level of CP were studies and the obtained results are shown in Table (2). It could be noticed that crude protein, total carbohydrate, and energy were slightly decreased in the produced pan bread, while ash and crude fiber contents were increased with increasing the levels of CP. This may be due to the relative high contents of ash and fiber in CP than those of fine wheat flour. These results are confirmed by those obtained by Chantaro et al., (2008).

Table (2): Chmical composition of pan bread produced from wheat flour replaced by different levels of CP (%On dry weight basis).

CP (%)	Crude Protein (%)	Total carbohydrate (%)	Fat (%)	Ash (%)	Crude fiber (%)	Energy (Kj)
Control(0)	9.87	85.40	3.55	0.45	0.73	1726.5
2	9.79	83.28	3.66	1.90	1.37	1693.8
4	9.65	83.14	3.75	2.03	1.43	1689.6
6	9.58	82.97	3.83	2.10	1.52	1691.5
8	9.45	82.84	3.91	2.20	1.60	1690.2

2% CP, 4% CP, 6% CP, 8% CP.

Rheological Properties:

Information on the rheological properties of dough will be useful for predicting the potential application of the wheat flour and also the quality of the end products (Mohammed et al., 2012). The effect of CP supplementation on rheological characteristics of fine wheat flour are summarized in Table (3). It can be noticed that water absorption (WA) increased with increasing level of CP from 60.67% (control sample) to 72.01% (sample with 8% substitution of CP). Similar effects on WA was recorded by Tanska et al., (2007) and Ashoush and Gadallah, (2011) when the dried carrot and mango peels were incorporated to wheat dough.

The explanation of this phenomenon is based partly on the fact that the fiber structure contains a large number of hydroxyl groups, which interact with the hydrogen bonds of water (Bouaziz et al., 2010, Gomez et al., 2011). Dough development time (DDT) increased from 6.17 to 7.91 min with 8% incorporation of CP. During this phase of mixing, water hydrates, the flour components and the dough are developed (Kohajdova et al., 2011 and Mohammed et al., 2012). Similar trends in DDT were observed by Borchani et al., (2011) and Ashoush and Gadallah, (2011). Increasing of DDT could be attributed to the fiber-gluten interaction, which prevents protein hydration (Gomez et al., 2011).

Dough stability (DS) is known to be related to the quality of the protein matrix, which is easily damaged by the incorporation of other ingredients (Gomez et al., 2012). Addition of CP concluded in increasing of DS from 6.83 to 10.35 min. These observations were similar with those obtained by Nassar et al., (2008), Ognean et al., (2010) and Anil, (2011) for orange by-products, commercial potato fibre and rice bran supplemented

wheat dough. This effect could be explained by a higher interaction between DF, water and flour proteins (Borchani et al., 2011).

Table (3): Effect of CP addition on rheological properties of wheat dough.

CP (%)	WA (%)	DDT (min)	DS (min)	MTI (BU)
Control(0)	60.67 ±0.35	6.17 ±0.2	6.83 ±0.13	33.32 ±0.15
2	61.23 ±0.37	7.33 ±0.29*	7.03 ±0.26	30.67±0.16*
4	69.40 ±0.10*	7.67 ±0.18*	9.88 ±0.19*	16.67±0.58*
6	69.83 ±0.32*	7.83 ±0.11*	10.17 ±0.29*	14.00±0.08*
8	72.01 ±0.25*	7.91 ±0.12*	10.35 ±0.22*	13.28±0.13*

Means (±standard deviation) in the same row with different letters are significantly different (P<0.05)

Significant with control * P < 0.05

From the measurements it was also concluded that increasing level of CP resulted in decrease of MTI. These results were in agreement with findings of *Nassar et al., (2008)* and *Kohajdova et al., (2011)*. Reduction of mixing tolerance index MTI can be observed due to interactions between fiber and gluten (*Wang et al., 2002, and Bouaziz et al., 2010*). Loaf volume is regarded as most important baked goods characteristic since it provides a qualitative measurement of baking performance (*Kohajdova and Karovicova, 2008*). Incorporation of CP to pan bread negatively affected loaf volume of final products with reduction of loaf volume from 535 cm³ (fine wheat flour) to 430 cm³ (fine wheat flour incorporated with 8% of CP (Table 4). This phenomenon was possibly a result of the fiber weaning or crippling dough structure and reducing CO₂ gas retention. Moreover, appreciable amounts of water could have strongly bound to the added fiber during baked goods making, so less water was available for the development of the starch-gluten network, causing an under-developed gluten network and reduced loaf volume (*Sivam et al. 2010*). Cambering of CP incorporated pan bread presented as height and specific volume was decreased with increasing level of CP in products (Table 4).

Table (4): Effect of adding CP to wheat flour on the physical properties of pan bread.

Dry carrot %	Height (Cm)	Weight (g)	Volume (Cm ³)	Specific volume (Cm ³ /g)
Control(0)	6.8	152.86	535	3.49
2	6.6	152.88	525	3.43
4	6.5	152.89	470	3.07
6	6.2	152.95	460	3.00
8	6.0	153.16	430	2.80

2% CP, 4% CP, 6% CP, 8% CP.

Sensory Evaluation:

Sensory evaluations of CP incorporated pan bread are presented in Table (5). Results showed that incorporation of CP significantly influences

taste and odor of pan bread. It has been primarily attributed to terpenoids and sugars which are mainly responsible for carrot flavor of CP (Jones, 2009). Pan bread with 6 and 8% of CP were significantly harder than pan bread prepared only from fine wheat flour. The hardening effect observed after addition of DF results from the dilution of gluten content (Sivam et al. 2010) and also due to the thickening of the walls surrounding the air bubbles in the crumb (Gomez et al. 2003). Increasing of CP level resulted in appreciable darker crust color of wheat rolls. Similar observations were found by Tanska et al., (2007) and Kumar and Kumar, (2011) for dried carrot incorporated breads and cookies. Evaluation of overall acceptability (Table 5) of wheat rolls showed that acceptance of products with higher content of CP (6 and 8%) was markedly decreased because it negatively affected taste, odor, color and hardness of final products.

Table (5): Sensory evaluation of pan bread produced from wheat flour containing different levels of CP.

CP %	General appearance							Odor (20)	Taste (20)	Over all score (100)
	Crust			Crumb			Shape (10)			
	Color (5)	Appearance (5)	Break Shred (10)	Color (10)	Grain (10)	Texture (10)				
Control (0)	a 4.75	a 4.56	a 8.10	a 9.30	a 8.90	a 9.20	a 9.50	a 18.40	a 18.70	a 91.60
2	ab 4.35	ab 4.15	ab 7.65	b 7.40	ab 7.90	b 7.85	b 8.00	a 17.40	ab 17.60	b 82.30
4	ab 4.10	a 3.75	b 6.95	b 7.65	b 7.60	b 8.10	b 7.95	b 16.00	a 17.35	b 79.45
6	b 3.90	b 3.50	ab 7.20	b 7.10	b 6.85	bc 7.35	b 7.95	b 15.60	b 15.40	b 74.25
8	b 3.60	b 3.60	ab 7.40	b 7.40	b 6.90	c 6.90	b 7.35	b 14.70	b 14.70	b 72.55

a, b, and c. Means (\pm standard deviation) in the same row with different letters are significantly different ($P < 0.05$)

CONCLUSION

CP investigated in this study can be considered as suitable ingredient for pan bread supplementation due to high content of DF, low energetic value and relatively high hydration properties. Furthermore it was found that addition of higher levels (6 and 8%) of CP to wheat flour CP negatively affected rheological parameters of wheat dough, qualitative and sensory properties of pan bread. These findings are in agreement with Gomez et al., (2003) which described that small additions of dietary fiber from different origin to wheat flour (at the 2% level) produced in general, very similar bread (a straight dough process) to the white bread without any noticeable damage to acceptability, but the addition of 5% could imply use of some additives to correct the rheological properties of dough and bread volume reduction.

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تأثير إضافة مسحوق الجزر علي الخواص الحسية والريولوجية لخبز القوالب
محمد عبد الحليم حسين * ، علاء الدين أحمد مرسى يونس**
وهشام عبد الرحمن عبد المجيد**
*** قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة – مصر**
**** قسم الاقتصاد المنزلي – كلية التربية النوعية – جامعة المنصورة – مصر**

تهدف هذه الدراسة الى تقدير التركيب الكيميائي و القدرة على امتصاص الماء لمسحوق الجزر الغنى بالألياف الغذائية، و أثر استبدال دقيق القمح بمسحوق الجزر بنسب ٢% و ٤% و ٦% و ٨% على الخواص الطبيعية للعجين باستخدام جهاز الفارينوجراف، و أيضا الخواص الحسية لخبز القوالب. وأظهرت النتائج أن مسحوق الجزر مصدر جيد للألياف الغذائية و أن له خصائص مميزة في القدرة على امتصاص الماء. و من أكثر الآثار المترتبة على خلط مسحوق الجزر بدقيق القمح هو زيادة كمية الماء الممتص بزيادة تركيزات مسحوق الجزر ، و تحسين ثبات العجين ، بينما تراجع نتائج قوة العجين. ولقد حصل خبز القوالب المضاف اليه ٤% من مسحوق الجزر على أعلى درجات قبول المستهلك.

قام بتحكيم البحث

أ.د / احمد عبد العزيز الرفاعي
أ.د / عبد الغنى محمود عبد الغنى
كلية الزراعة – جامعة المنصورة
كلية التربية النوعية – جامعة المنصورة