PREGELATINIZED CORN STARCH AS A SOURCE OF LOW CALORIC INGREDIENT IN WHITE PAN BREAD

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Abstract

Obesity is considered one of the most important malnutrition disorders. To avoid the adverse effects of the high calorie diets, blood triglyceride and high cholesterol level on human health, the wheat flour was replaced by 5, 10, 15, 20 and 25 % pregelatinized corn starch (modified starch) for production of a low caloric pan bread. The effect of this replacement on the gross chemical composition, staling rate, carbohydrate digestibility and organolyptic properties of produced pan bread was studied. Crude protein and fiber contents of pan bread were less than the control pan bread. Total carbohydrate was increased with the replacement pregelatinized corn starch increases. Staling rate of the produced bread after 72 hrs noted an increase in freshness of the replaced pan bread formulated samples. The carbohydrate digestibility was proportional decreased with the percentage of replacement increase.

INTRODUCTION

Obesity is a major health problem for many peoples. It is one of the most common risk factors predisposing the high blood pressure, diabetes mellitus, certain cancers and other conditions (McGinnis and Ballard-Barbash, 1991). On the other hand, consumers' awareness of health risks associated with the high calorie, fat and cholesterol contents. Therefore, (Demak-Wahnerfried *et al.*, 1990) have prompted the baking industry to modify products to be low in these components that are considered health prompting such as fiber.

Modified starches for a long time are used in food and non-food industries. In food, a modified food starch derived from corn, can reduce the fat content of such food applications as margarines, chess spreads and baked product, (Pszczola, 1991). Low-fat beef petties were produced by replacing fat with modified corn starch/water combination at different ratios, (Khalil, 2000). Also, the native starch had higher digestibility than modified food starch (Jaussan *et al.*, 1992). In contrast, the low fat baked product contains modified food starch which is less in calories than a corresponding full fat, (Anon, 1993).

Pregelatinized starch is a type of modified food starches. In foods, the pregelatinized starch can be applied in almost any instance in water thickening or water holding (Anastasiades *et al.,* 2002).

Wells (1994) described cake recipe formulated with pregelatinized starch are suitable for backing in a microwave oven. Viscosity is regulated by pregelatinized starch to give good quality bakery products. Also, pregelatinized starch was used in manufacture indirect expanded snacks for reducing the calorie content of food, (Wang, 1997).

In this study, up to 25% wheat flour was replaced with different percentages of pregelatinized corn starch to produce low calorie pan bread. Gross chemical composition, staling rate, carbohydrate digestibility and organolyptic evaluation were carried out.

MATERIALS AND METHODS

Materials:

Wheat flour: A wheat flour of 72 % extraction (Giza 156 variety) was obtained from the North Cairo Flour Mills Company, Egypt.

Pregelatinized corn starch (moisture 5%, viscosity 1100 C.P. and solubility 80 % at 95 °C) was obtained from the Egyptian Starch and Glucose Manufacturing Company, Egypt.

Other materials: Salt, sugar, corn oil and compressed yeast were purchased from local market.

Methods:

Preparation of bread samples:

Five samples of wheat flour were substituted with 5,10, 15, 20 and 25 % Pregelatinized corn starch and control samples (100 % wheat flour of 72 % extraction). Baking formula was prepared based on flour weight as follows:

Components	Sample number					
	Control	1	2	3	4	5
Wheat flour	100	95	90	85	80	75
Pregelatinized starch	-	5	10	15	20	25
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Sugar	1	1	1	1	1	1
Compressed yeast	2	2	2	2	2	2
Corn oil	3	3	3	3	3	3

Bread was prepared using the straight dough procedure. Fermentation continued for 60 min in a cabinet at 35 °C and 85 % relative humidity. The bread samples were baked in a rotary oven at 250 °C for 15 min. (Abu El-maati, 1999).

Chemical composition of pan bread:

Moisture, protein, fat, ash and crude fiber contents were determined according to the method described in AOAC (2000).Carbohydrates were calculated by difference as follows:

Carbohydrates = 100 – (% moisture + % protein + % total lipid + % ash + % crude fiber).

Determination of staling rate:

Staling rate of pan bread was directly determined after baking, then after 24, 48, and 72 hrs. using the Alkaline Water Retention Capacity (AWRC) method as described by Kitterman and Rubenthaler (1971).

Carbohydrate digestibility of pan bread (in-vitro):

Carbohydrate digestibility (*in-vitro)* was determined by using pancreatic ∝-amylase according to the method reported by Singh *et al.* (1982).

Organolyptic evaluation of baked bread:

Organolyptic evaluation was evaluated including: Odor, taste and general appearance, i.e. crust (color, appearance and break shred), crumb (color, grain and texture) and shape according to Matz (1960).

Statistical analysis:

The obtained results of organoleptic evaluation were statistically analyzed by the least significant differences (LSD) at the $p \leq 0.05$ according to the method described by Freund and Williams (1982).

RESULTS AND DISCUSSION

Chemical composition of pan bread:

The chemical composition of the six pan bread samples was studied and the results are illustrated in Table 1.

Table 1. Chemical composition of pan bread replaced with pergelatinized corn starch (on dry weight basis).

Constituent	Control	Pregelatinized corn starch				
		5%	10%	15%	20%	25%
Moisture %	21.98	22.07	23.63	24.42	23.01	23.73
Crude protein %	11.51	10.96	10.72	9.82	9.85	8.49
Total lipid %	3.62	3.70	4.18	4.16	3.70	4.01
Ash %	1.54	1.46	1.41	1.34	1.30	1.22
Crude fiber %	2.47	2.21	1.92	1.69	1.51	1.35
Total carbohydrate* %	80.86	81.67	81.77	82.99	83.64	84.93

* Calculated by difference

From the obtained result, it could be found that the moisture content was slightly increased after addition of pregelatinized corn starch. Anon (1993) showed that the addition of pregelatinized corn starch increases water absorption. Total carbohydrate content of formulated pan bread samples increased with increasing the replacement percent pregelatinized corn starch. On the other hand, there was notic able decrease in the crude protein from 11.51 % in the control sample to 8.49% in the pan bread containing 25% pregelatinized corn starch. Crude fiber varied from 2.47 % in the pan bread (control) to 1.35 % in the pan bread contenting 25 % pregelatinized corn starch.

Staling rate of pan bread:

The staling rate (freshness value) of the tested pan bread samples was directly measured after baking then after 24, 48 and 72 hrs. Results in Table (2) clearly showed that after 24 hrs. of baking freshness values of the tested samples were actually decreased within the range from –8.55 to –25.51 %. Staling rate was developed more rapidly in control pan bread than the pan bread replaced with different percentage of pergelatinized corn starch. The same trend was observed for freshness value after 48 and 72 hrs. After baking process, the percentage decrease of freshness value ranged from –11.03 to –27.21 % after 48 hrs. and from –18.82 to –30.02 % after 72 hrs.

Pszczola (1991) used a modified food starch in different food products. He mentioned that the modified food starch can increase the shelf life of the produced products and the shelf life of such baked products can be extended in excess of 15 days by addition of modified food starch.

Table 2. Effect of pregelatinized corn starch replacement percents on staling rate of pan bread during 72 hrs after backing

Bread samples	Zero time	24 hrs		48 hrs		72 hrs	
		Value	Decrease%	Value	Decrease%	Value	Decrease%
Control	384.71	286.56	-25.51	280.03	-27.21	268.27	-30.03
Pregelatinized Corn starch:							
5%	341.58	285.25	-16.49	278.09	-18.59	265.73	-22.21
10%	339.89	289.62	-14.79	284.19	-16.39	262.16	-22.29
15%	329.37	281.26	-14.50	274.62	-16.61	263.86	-19.88
20%	338.00	299.30	-11.45	293.04	-13.30	266.65	-21.108
25%	322.39	294.82	-8.55	286.82	-11.034	261.70	-18.826

Carbohydrate digestibility(in-vitro) of pan bread:

The *in-vitro* carbohydrate digestibility of tested pan bread was determined and the obtained results are illustrated in Table 3 and Figure 1.

Table 3. Enzymatic carbohydrate digestibility of pan bread replaced with different percentage of pergelatinized corn starch

Bread samples	Carbohydrate digestibility %
Control	76.60
Pregelatinized corn starch:	
5%	66.91
10%	59.33
15%	55.54
20%	47.81
25%	44.62

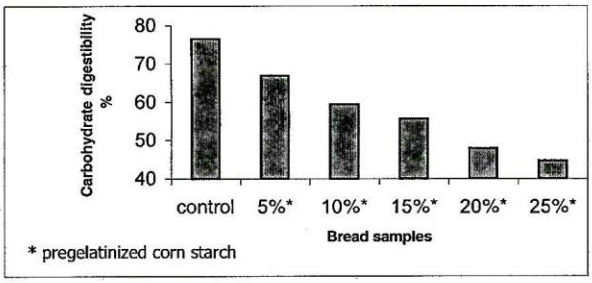

Figure 1. Enzymatic carbohydrate digestibility of pan bread samples.

The results showed that the carbohydrate digestibility of pan bread is affected by substitution percent of pergelatinized corn starch. The carbohydrate digestibility of control pan bread was the highest percentage (76.60) compared with the other tested samples. From the obtained data, it could be noticed that the pregelatinized corn starch highly decreased the digestibility of carbohydrate. Swanson *et al.* (2000) indicated that pancreatic ∝- amylase is the primary enzyme responsible for the initial hydrolysis of ∝-linked glucose in the small intestinal lumen. Wang (1997) studied that *in-vitro* digestibility by pancreatic ∝-amylase for modified and unmodified starch. He found 10 – 15 % less digested for modified starch than unmodified starch. Also, the differences between modified and unmodified starch were reduced by boiling the starch.

Modified food starch vary in their susceptibility to enzymatic hydrolysis. This variation depends on the botanical origin of the starch, the modifying agent(s) used, the subsequent chemicals bonds and derivatives formed, the extent of granule gelatinzation, the choice enzyme and type of cooking (Pszczola, 1991).

Therefore, the modified food starch (pergelatinized corn starch) could be used as an alternative substitute of wheat flour for producing a low calorie pan bread.

Organolyptic evaluation of pan bread:

Pan bread samples were laboratory prepared and baked then the organolyptic evaluation was measured for its characteristics, i.e. general appearance (crust, crumb and shape), odor and taste.

Results in Table 4 showed that the total scores of the tested pan bread samples were fairly decreased with increasing the percentage of pregelatinized corn starch. These decreases were pronounced in bread, which contain 20 and 25 % pregelatinized corn starch. The statistical analysis of organoleptic evaluation data illustrated, there were significant ($p \leq 0.05$) differences between pan bread control sample and pan bread replacement with pregelatinized corn starch. Additionally, there were significant ($p \leq 0.05$) differences among the tested pan bread according to the replacement percent.

The decrease in appearance scores with the higher percentage of pregelatinized corn starch may be related to the Egyptian food habits. On the other hand, Chaudhry (1981) found that the low fat baked product which contains modified food starch is moist and has a good mouthfeel.

Table 4. Organoleptic evaluation of pan bread replaced with different percent of pregelatinzed corn starch.

Bread samples	General appearance							Odor (20)	Taste (20)	Totel scores (20)
	Crust			Crump			Shape (10)			
	Color (5)	Appearance (5)	Break Shred (5)	Color (10)	Grain (10)	Texture (10)				
Control Pergel*	a 4.50 ± 0.71	4.50 ± 0.21	a 8.58 ± 0.31	a 7.78 ± 0.18	a 8.17 ± 0.18	a 9.10 ± 0.35	a 8.90 ± 0.21	19.33 ± 0.04	a 18.75 ± 0.52	89.61
5%	a 4.45 ± 0.27	a 4.80±0.42	a 8.60 ± 0.33	b 9.13 ± 0.20	b 8.61 ± 0.28	b 8.53±0.33	b 8.10 ± 0.28	a 18.33 ± 0.14	b 17.13 ± 0.33	87.69
10%	a 4.89 ± 0.31	a 4.70 ± 0.30	b 9.33 ± 0.37	b 9.47 ± 0.37	a 8.43 ± 0.24	b 8.33 ± 0.34	c 9.50 ± 0.22	17.23 ± 0.33	c 15.50±0.43	87.38
15%	a 4.54 ± 0.26	b 3.55 ± 0.28	a 8.57 ± 0.40	b 9.27 ± 0.33	7.67 ± 0.19	a 9.10±0.26	c 9.85 ± 0.13	b 16.28 ± 0.38	a 18.38 ± 0.40	87.21
20%	a 3.77 ± 0.38	a 4.55 ± 0.28	a 8.50 ± 0.15	a 8.20 ± 0.31	9.33±0.14	a 9.35 ± 0.18	b 8.47 ± 0.28	b 16.30 ± 0.32	c 15.68 ± 0.15	84.15
25%	b 3.47 ± 0.40	b 3.83 ± 0.40	a 8.08 ± 0.31	b 8.60 ± 0.28	b 8.70 ± 0.28	b 8.53 ± 0.31	a 8.60 ± 0.31	a 18.42 ± 0.21	b 17.07 ± 0.16	85.30
L. S. D.	0.245	0.235	0.229	0.208	0.151	0.209	0.175	0.195	0.214	

*Pregelatinzed corn starch

Within the same column values not sharing same superscript are significantly ($p \leq 0.05$) different

CONCLUSION

Innovated pan bread for regime was produced using wheat flour replaced by different percentages (5, 10, 15, 20 and 25 %) of pergelatinized corn starch. The enzymatic carbohydrate digestibility was decreased with the increases of modified starch replacement. Staling rate was developed more rapidly in pan bread (control) than the replaced pan bread. On the other hand, these replacements slightly affect the organolyptic properties of the produced bread comparing the control sample.

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نشا الذرة المحور كمصدر لخفض محتوى السعرات الحرارية فى خبز القوالب

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البدانة هي أحد أمراض سوء التغذية الشائعة في العالم و الغرض من هذه التجربة هو تقليل تأثير ارتفاع السعرات في الوجبات على صحة المستهلك. في هذه التجربة تم استبدال نسبه من دقيق الخبز باستعمال نسب ٥، ١٠، ١٥، ٢٠، ٢٥% من النشا المحور لتقليل نسبه هضمه و خفض محتوى السعرات الحرارية . أثرت نسب الاستبدال المذكورة على الصفات الحسيه بانخفاضها الطفيف عن العينه الضابطة. كما لوحظ انخفاض في محتوى البروتين و الألياف و ارتفاع فى محتوى الكربوهيدرات الكلية بالمقارنة بالعينة الضابطة. كما أظهر تقدير نسب القيمة الهضمية للكربوهيدرات انخفاضها كلما زادت نسبه أضافه النشا المحور للعينه.