HIGH FIBER BREAD

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ABSTRACT

To produce high fiber bread characterized with minimum phytate phosphorous and moderate protein content, the chemical contituents of commercial bread and low calories bread were studied. Also, the distribution of phytate, fiber and ash of red and white wheat kernels and their milling products were subjected to different analyses. Results showed that most of the phytate was found in the germ and coarse bran. White wheat shorts was chosen because of its low phytate phosphorous and high fiber content in addition to its palatability than coarse and fine bran. Factors affecting phytate hydrolysis (incubation. toasting and yeast addition), the rheological properties of mixing shorts with wheat flour and its nutritional constituents were studied. High fiber bread which contains 25% shorts is the suitable formula due to its moderate fiber content.

INTRODUCTION

Recent interest in dietary fiber arises from epidemiological observation which linked the take of plant fiber in the diet with the prevalence of certain degenerative diseases in industrial societies. Wheat bran is suggested as a source of dietary fiber since it is not expensive and is well accepted by consumers (Southgate et al., 1976). According to Schweizer et al. (1984), wheat bran contains 6.2% ash; 43.4% dietary fiber; 4.2% sugars; 18.7% starch; 6.2% lipids and 16.9% protein.

From the nutritional point of view, reduction of wheat bran phytate is favourable due to its combination with divalent metals (e.g. Zn and Fe) to form compounds with low solubility which are not readily absorbed from the intestine (Harland and Harland, 1980). Also they reported that yeast phosphatase hydrolize phytate to ortho phosphate and inositol. Therefore, they observed that increasing the amount of yeast or extending the fermentation time reduce the phytate content.

Phytase is also present in bacteria, yeasts and fungi. The disappearance of phytate and the concurrent appearance of inorganic phosphate in yeast-raised bread was observed by several investigators (Harland and Harland, 1980; Tangkongchitr et al., 1981 and Nayini & Markakis, 1983). Wang et al. (1980), found that the optimum pH of the phytase enzyme was 5.3 as an acid phosphohydrolase and its maximum activity was at 50°C. Also, the enzyme is fairly stable over pH ranged from 3.5 to 7.8 at 25°C.

This study was designed to investigate the factors affecting phytate content in a trial to produce high fiber bread characterized with minimum phytate phosphorous and moderate protein content.

MATERIALS AND METHODS

Samples of commercial common bread and high fiber bread were obtained from different sources and subjected to comparative study regarding moisture, ash, crude protein, dietary fiber, lipids, available carbohydrates, phytate phosphorous contents and calories.

The whole grains of imported red and white wheat (*Triticum aestivium* L.) varieties in addition to their flour (72 and 82% exraction rate) red dogs, shorts, fine coarse bran and wheat germ were prepared at Research and Experimental Lab. North Cairo Milling Company.

1- Chemical analysis:

Moisture, ash, crude protein (N X 5.7) lipids and reducing and non reducing sugars were determined according to A.O.A.C. (1980). Starch was determined enzymatically using diastase enzyme as mentioned by Kerr et al. (1951). Crude fiber was carried out according to Rafai (1965), while, dietary fiber was calculated using the following equation.

Dietary fiber = 100 - (total protein + sugars + starch + lipids + ash)

Phytic acid was determined according to Lopez et al., (1983). Total calories were calculated using the equation mentioned by Yadkin and Offord (1980).

E = 4 (% protein + % carbohydrate) + 9 x fat

Where E = energy as calories per 100 grams

2- Rheological properties:

The rheological properties of the doughs were carried out using a Farinograph and Extensograph tests according to A.A.C.C. (1962).

Preparation of bread:

The suggested formula was prepared by mixing shorts (15, 25, 40 and 50%) with patent flour, sodium chloride 1% as well as yeast of 2% and water (according to Farinograph absorption). The previous ingredients were mixed and fermented for 60 minutes at 30°C then the doughs were cutted to equal pieces, placed on trays, fermented for another 30 minutes and baked at 230°C.

RESULTS AND DISCUSSION

The results reported herein deal with **(a)** The chemical analysis of ordinary bread and low calories bread available in the Egyptian market and **(b)** The possiblity of producing high fiber bread with low phytate content.

a- Analysis of commercial ordinary bread and low calories bread:

The chemical constituents of commercial bread and low calories bread obtained from different sources of the local market are presented in Table (1). Europian white bread contained higher crude protein and carbohydrate rates than balady bread. Balady bread was characterized by its higher ash, fiber and phytate phosphorous content due to the addition of fine bran to the loaf. From energetic stand point, Europian white bread had higher calories content than other samples under investigation.

Tep Tup tust had lower; moisture; crude protein; dietary fiber and phytate phosphorous and higher; ash, lipids and carbohdrates content than other Regime tust. High lipids content in Europian white, Tep Tup Regime tust bread could be attributed to the oil which added to the pan while baking to prevent bread stickness.

Short bread showed some differences in its chemical constituents. Ash carbohydrates and phytate phosphorous were higher in short bread of Great Cairo Company while, Protein and lipids were higher in North Cairo short bread.

Table(1): Analysis of commercial ordinary bread and low calories bread (on dry basis).

Sources	Type of Bread	Moisture %	Ash %	Crude protein %	Dietary fiber %	Lipids %	Available carbohyd-rate %	Phytate phosphorous %	Calories K.Calories
1- Common bread									
North Cairo Co.	Eurcpian white	34.00	1.56	10.11	2.83	2.50	83.00	0.041	394.94
	Balady	37.08	7.98	9.90	3.30	1.30	82.45	0.103	381.10
2- Low calories bread									
Biscomasr	Regime tust	36.55	2.98	22.20	17.69	2.44	60.71	0.288	329.60
Tep Tup	Tust	30.23	3.26	12.31	16.29	3.20	64.94	0.227	337.80
North Cairo Co.	Shorts I	36.68	2.61	18.87	17.69	1.80	59.08	0.298	328.00
Great Cairo Co.	Shorts II	36.00	3.19	12.89	17.90	1.30	64.72	0.452	322.14

Higher protein content of Regime tust and flatend short (1) bread could due be to the use of gluten in bread making. The low biological protein value may harm the kidney specially patients who suffer from renal disease (Davison et al., 1975).

Carbohydrates percentage in low calories bread were lower than white or balady bread, reduction was not enough because it contained more than 50% carbohydrates (Anon, 1978) and calories reduction were 16.5-18.4%.

As shown from table (1) as phytate phosphorous increased fiber content increased and calories content decreased. Shorts (2) bread had the lowest calories and highest fiber and phytate contents. Phytate ion chelates with several elements including copper, zinc, cobalt, magnesium, iron and calcium (Harland and Harland, 1980). Therefore, it is favourable to proudce high fiber bread with low phytate and available carbohydrate content.

b- Production of high fiber bread with low phytate content:

To acheive this goal, wheat milling products were analysed to determine their phytate phosphorous, ash and dietary fiber content in order to choose a fiber source which contains high fiber and less phytate.

I- Chemical Analysis:

1-1- Distribution of phytate, fiber and ash contents in red and white kernels and their milling products:

Data reported in table (2) indicate that red wheat kernels contained higher amounts of phytate phosphorous, crude fiber and ash content than white kernels. Also, red wheat kernels milling proudcts had higher phytate, crude fiber and ash content than white wheat kernels. Flour of 72% extraction rate from both wheat types showed almost close ratios comparing with the other milling products. Coarse bran contained higher, phytate, crude fiber and ash content. White wheat germ had the highest phytate and ash contents. These results indicate that most of the phytate is located in the germ and coarse bran. The obtained data are in agreement with those reported by O'Dell et al., (1972) and Kent, (1983).

The ratio between phytate phosphorous and fiber was higher in red wheat fine bran and shorts than in white fine bran and shorts. According to the obtained results, white shorts was chosen as a source of low phytate phosphorous and high fiber content. Also, white wheat shorts of produced from wheat kernels low ash content is more palatable for man than coares and fine bran.

Table (2): Distribution of phytate, fiber, and ash among wheat kernels milling products. (on dry basis).

Content	Red Wheat				White wheat			
	Phytate phosphorous %	Crude fiber %	Ash %	Phytate phosphorous / Fiber	Phytate phosphorus %	Crude Fiber %	Ash %	Phytate phosphorus / Fiber %
Whole wheat kernels	0.32	2.22	1.78	14.41	0.24	1.96	1.51	12.24
Flour (72% ext.)	0.09	0.20	0.57	45.00	0.09	0.19	0.53	47.37
Flour (82% ext.)	0.18	0.40	0.81	45.00	0.14	0.30	0.72	46.66
Red dog	0.62	3.27	2.18	16.66	0.53	3.02	2.08	17.54
Shorts	1.173	7.60	2.78	15.43	0.77	6.20	2.55	12.42
Fine bran	1.306	10.66	3.81	12.25	0.96	8.46	3.20	11.35
Coarse bran	1.332	13.26	6.03	10.04	1.05	9.89	4.85	10.62
Wheat germ	-	-	-	-	1.42	2.62	3.79	54.20

1-2- Factors affecting phytate hydrolysis:

In order to reduce phytate content in wheat shorts, incubation, toasting and yeast addition were studied.

1-2-1- Effect of incubation:

The results concerning the effect of incubation on white and red wheat shorts by using tap water (pH 6.8-7) and acetic acid solution (pH 4.3) at 30, 40 and 50°C for 1,3,3 and 4 hours are shown in table (3). Phytate phosphorous loss increased by increasing time at all incubation temperatures for both tap water and acetic acid solution (Phytase activity of white shorts was higher than that of red shorts). The highest loss percentage was obtained after 3 hrs. by using tap water at 40°C for white wheat shorts and 4 hrs at 40°C for red wheat shorts. These results indicate that tap water had higher favourable effect on shorts incubation at different temperatures and periods. These observations are in agreement with those reported by Wang *et al.*, (1980).

1-2-2- Effect of toasting:

Results in table (4) show the effect of toasting treatments on phytate phosphorous loss. Toasted bread which contained 15 and 25% shorts showed almost the same phytate loss percentages while that containing 40 and 50% short showed lower phytate loss percentages. The results indicate that toast treatment reduces phytate phosphorous content specially at low shorts addition (less than 25%) then the phytate loss was very slow which may be due to the thermal destructive effect of phosphatase enzyme.

The obtained results indicate that toasting had a limited effect on phytate destruction rate. These results are in agreement with those reported by De Boland *et al.*, (1975) and Wozenski and Woodrun (1975).

1-2-3- Effect of yeast fermentation:

Data in table (5) show the effect of yeast on phytate phosphorous loss in the bread which contains 25% shorts with the following treatments:

1- 2% yeast added at mixing of ingredients.
2- 2% yeast added at mixing and bread toasted.
3- 2% yeast added at mixing of the incubation shorts + flour + salt.
4- 2% yeast (from flour + shorts) added before incubation.

The relevant results of these different factors are present in table (5) which indicate that incubation of shorts for two hrs. before yeast addition showed the highest

Table (3): Effect of incubation of shorts[1] on phytate destruction (on dry basis).

Incubation		Acetic acid solution (pH 4.3)				Tap water (pH 7)			
		White wheat shorts phytate phosphorous		Red wheat shorts phytate phosphorous		White wheat shorts phytate phosphorous		Red wheat shorts phytate phosphorous	
Temperature	Hours	Conc. %	Loss %	Conc. %	Loss %	Conc. %	Loss %	Conc. %	Loss %
30°C	-	0.775	-	1.173	-	0.775	-	1.173	-
	1	0.454	41.3	0.980	16.4	0.245	68.4	0.725	38.2
	2	0.385	50.2	0.803	31.5	0.190	75.4	0.517	55.9
	3	0.325	58.0	0.749	36.2	0.163	78.9	0.505	56.9
	4	0.254	67.2	0.640	45.4	0.136	82.4	0.492	58.1
40°C	1	0.259	66.6	0.899	23.4	0.155	80.0	0.626	54.4
	2	0.207	73.3	0.667	43.2	0.129	83.3	0.424	63.8
	3	0.168	78.3	0.545	53.6	0.065	91.6	0.378	67.8
	4	0.154	80.1	0.490	58.2	0.065	91.6	0.330	71.9
50°C	1	0.310	60.0	0.572	51.2	0.272	64.9	0.527	55.0
	2	0.293	62.1	0.545	53.6	0.258	66.7	0.483	58.8
	3	0.237	69.3	0.483	58.8	0.191	75.3	0.425	63.8
	4	0.198	74.4	0.463	60.5	0.082	89.4	0.335	71.4

(1) 30 g. shorts + 70 cm water or solution.

Table (4): Effect of toasted high fiber bread on phytate phosphorus loss (on dry basis).

Shorts in bread %	Toast treatment %	Flour phytate phosphorus %	Bread phytate phosphorus %	Phytate phosphorus loss %	Phytate toasted loss[1] %
15	-	0.203	0.096	52.70	-
15	toasted	-	0.072	64.53	25.00
25	-	0.277	0.126	54.51	-
15	toasted	-	0.095	65.70	24.60
40	-	0.390	0.244	37.43	-
40	toasted	-	0.186	52.30	23.77
50	-	0.465	0.359	22.70	-
50	toasted	-	0.291	37.42	18.94

(1) Phytate toasted loss % =

$$\frac{\text{Bread phytate} - \text{bread phytate after toasted}}{\text{Bread phytate}} \times 100$$

Table (5): Effect of different factors on phytate hydrolysis in high fiber bread (25% shorts) on dry basis.

	Yeast addition to shorts during incubation	Shorts incubation time before dough mixing	Toasted treatment	Bread phytate phosphorus	Phytate loss
	%	hours		%	%
1	-	-	-	0.126	54.51
2	-	-	toasted	0.095	65.70
3	-	2	toasted	0.019	93.14
4	2	2	toasted	0.207	25.27

value of phytate destruction. This observation may be due to the extending time of the hydrolysis (two hrs. incubation plus 1.5 hrs. fermentation). On the other side, the addition of yeast to shorts before incubation showed the lowest value of phytate destruction. This may be due to the hindering effect of yeast addition on phytate activity. The obtained results in this respect are in agreement with those reported by Harland and Harland (1980) and Tangkongchiter et al., (1981).

II- Rheological Properties:

Farinograph test:

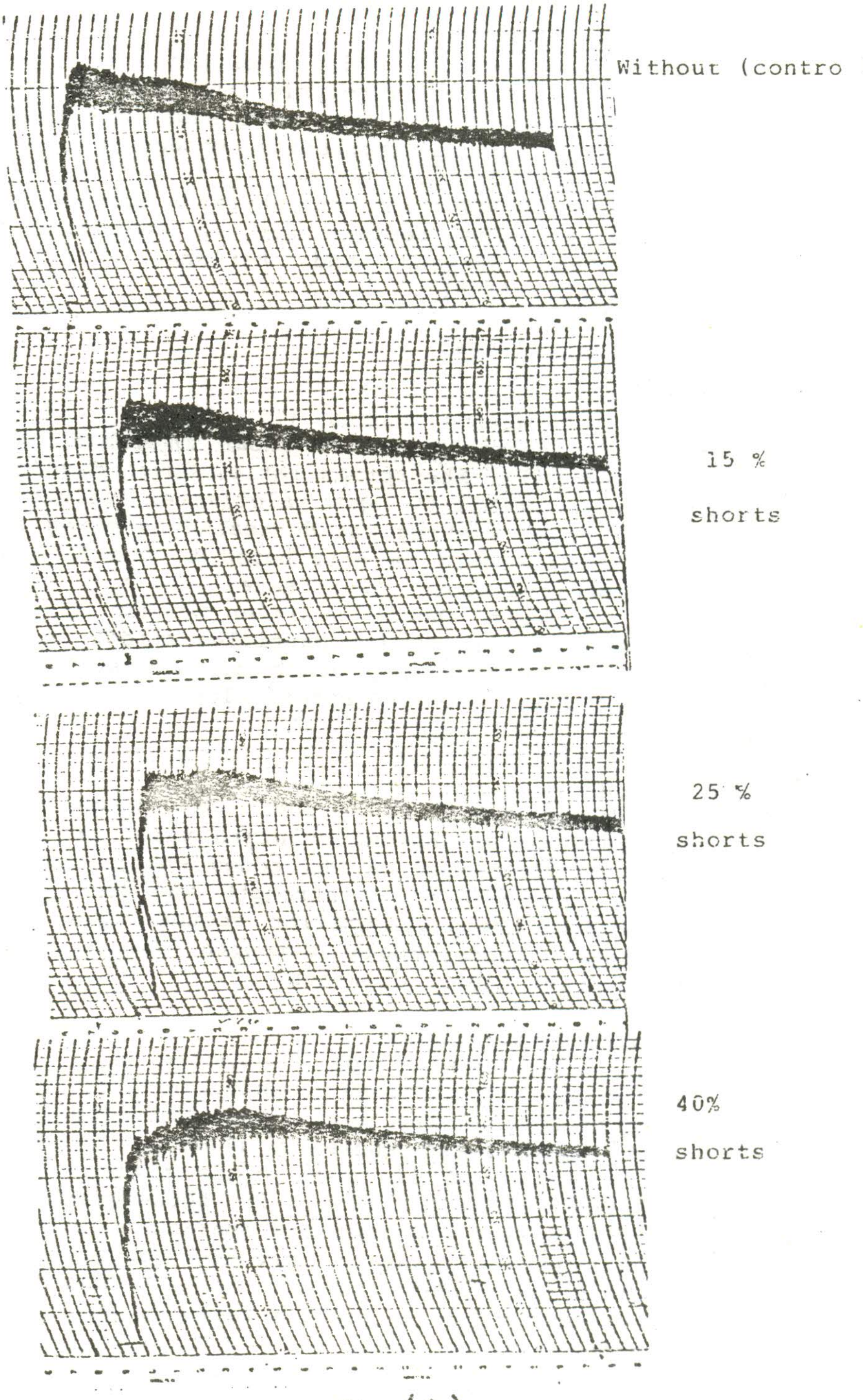
The effect of mixing shorts (15, 25 and 40%) with wheat flour on farinograph test is shown in table (6) and illustrated in Fig. (1). Absorption ratio, dough development time, arrival time, stability and valorimeter values were increased while, dough weaking was decreased as mixed shorts increased. Such trend could be attributed to the high water absorption of hemicellulose (Pentosane) content of bran (Refai, 1965). In fact shorts addition weaken the dough due to gluten dilution and to its particles effect on gluten shearing. However, weaking the dough is a result of the break down of gluten network after elapsing appropriate mixing time.

Extensorgaph test:

The results in table (7) proved that dough extensibility, resistance to extension, strength value and proportional number were decreased as the added shorts increased. Shorts addition weakened dough strength and hence, it is expected to produce bread of smaller volume than that of 100% wheat flour. Also, dough strength value reduction could be due to dough gluten dilution.

III- Nutritional Constituents:

Table (8) shows the effect of shorts addition (15, 25 and 40%) on the nutritional constituents of the high fiber bread produced by the new suggested technique. The suggested high fiber bread showed a negative relationship between its calories and its ash, crude protein, dietary fiber and lipids content. Also, it showed a positive relationhsip between its calories and available carbohdyrate content. These results revealed that the suggested shorts bread is lower in its phytate content than any other commercial high fiber bread due to phytase activity during shorts incubation before mixing. Also, from the nutritional point of view less phytate leads to high availability of divalent metals (O'Dell et al., 1972 and Kent, 1983). As a general conclusion the high fiber bread which contains 25% shorts



Fig(1)

Farinogram of shorts addition to flour.

Table (6): Farinogram of suggested high fiber bread(1).

	Water absorption %	Dough developing time min	Arrival time min	Stability mixing tolerance min	Valorimeter value	Degree of softening after 10 min.	20 min.
Flour	52.1	1.6	0.6	5.2	37	80	130
85% flour + 15% shorts	54.5	3.0	2.1	5.5	42	65	125
75% flour + 25 shorts	58.4	3.5	2.2	6.7	50	40	85
60% flour + 40 shorts	62.7	6.0	4.1	8.5	55	20	60

(1) on 14% moisture basis.

Table (7): Extensigram of suggested high fiber bread.

Contents	Extensibility mm	Resistance to extension B.U.	Proportional number	Dough strength cm^2
Flour	177	320	1.808	93
85% Flour + 15% shorts	153	220	1.438	45
75% flour + 25% shorts	138	160	1.159	25
60% flour + 40 shorts	75	180	2.25	20

Table (8): Nutritional constituents of suggested toasted high fiber breads (short bread)[1] (on dry basis).

Shorts %	Ash %	Dieatry fiber %	Total protein %	Lipids %	Available carbohydrate %	Phytate phosphorus %	Calories for 100 g K.Cal
15	2.17	6.63	11.40	1.80	78.00	0.13	373.8
25	2.55	11.18	12.25	2.20	72.45	0.019	358.6
40	3.12	17.70	12.97	2.80	63.41	0.047	330.72
Balady bread (control)	1.98	3.30	9.9	1.30	82.45	0.103	381.10

(1) Shorts incubated two hours at 40°C with water before dough mixing.

is prefered than others (15 and 40% shorts) due to its moderate amount of fiber. Also, its extensogram properties showed that addition of high shorts weakened dough strength and produced smaller bread volume.

REFERENCES

A.A.C.C. (1962): American Association of Cereal Chemists, Aproved methods, 8th edition, st. Paul. U.S.A.

Anon (1978): Foods of special dietary uses, low calories bread, Egyptian Standard, 1432. Egyptian Organization for Standardization.

A.O.A.C. (1980): Association of official analytical chemists, "Official Methods of Analysis". 13th eddition, Washington.

Bourdet, A. and Fillet, P. (1967): Distribution of phosphorous compounds in the protein fraction of various types of wheat flours. Cereal Chem. Vol. 44.

Davidson, S.; Passmore, R.; Brock, J.F. and Truswell, A.S. (1975): Human Nutrition and Dietetics. 6th eddition. E.L.B.S.

De-Boland, A.R.; Garmer, G.B. and O'Dell, B.L. (1975): Identification and properties of "phytate" in cereal grains and oil seed products. J. Agric. Food Chem. 23: 1186.

Harland, B.F. and Harland, J. (1980): Fermentive reduction of phytate in Rye, white and whole wheat breads. Cereal Chem. 57(3): 226-229.

Kent, N.L. (1983): Technology of cereals. Pergman press, Third Eddition.

Kerr, R.W.; Cleveland, F.C. and Katzbeck, W.J. (1951): The action of amyloglucosidase on amylose and amylopectin. J. Am. Chem. Sco., 73: 3916-21.

Lopez, J.; Gordon, D.T. and Fields, M.L. (1983): Release of phosphorous from phytate by natural lactic acid fermentation. J. Food Sci., Vol. 48: 953-959.

Nayini, N.R. and Markakis, P. (1983): Effect of fermentation time on the inositol phosphates of bread. J. Food Sci. 48: 262.

O'Dell, B.L.; De-Boland, A.R. and Koirtyohann, S.R. (1972): Distribution of phytate and nutritional important among the morphological components of cereal grains. J. Agric. Food. Chem. 20(3): 772.

Refai, F.Y. (1965): Essential of milling industry. Pub. By the General Establishment of Mills and Bakeries. (In Arabic).

Schweizer, T.F.; Frolish, W.; Vedovo, S. and Besson, L. (1984): Minerals and phytate in the analysis of dietary fiber from cereal. Cereal Chem. 61(2): 116-119.

Southgate, D.A.; Branch, W.J.; Drasar, B.S.; Walters, R.L.; Davies, P.S. and Mclean, B.I. (1976): Metabolic responses to dietary supplements of bran. Metabolism 25: 1129.

Tangkongchiter, U.; Seib, P.A. and Hoseny, R. (1981): Phytic acid. I. Determination of three forms of phosphorous in flour, dough and bread. Cereal Chem. 58(3): 226-228.

Wang, W.L.; Swain, E.W. and Hesseltine, C.W. (1980): Phytate of molds used in oriental food fermentation. J. Food Sci. 45: 1262-1266.

Wozenski, J. and Woodurn, M. (1975): Cereal Chem. 52, 665. (c.f. Mago, J.A., [1982] J. Agric. Food Chem. Vol. 30 No. 1 Reviews).

Yadkin, M. and Offord, R. (1980): Comprehensible Biochemistry. E.L.B.S.

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لانتاج خبز عالى الألياف يحتوى على أقل نسبة ممكنة من الفيتات ونسبة متوسطة من البروتين تمت دراسة الخواص الكيميائية لعدد من أنواع الخبز التجارى المنخفض السعرات وكذا توزيع الفيتات والألياف والرماد فى حبوب القمح الأحمر والأبيض ومنتجات طحنها • أظهرت النتائج أن معظم الفيتات تتواجد فى جنين القمح والنخالة وقد تم اختبار السن الأحمر للقمح الأبيض كمصدر عالى للألياف ومنخفض فى نسبة الفيتات وفى نفس الوقت له قابلية للأكل عن كل من النخالة الناعمة والخشنة • تمت دراسة العوامل التى تؤثر على تحلل الفيتات (التحضين ، التحميص واضافة الخميرة) وتبين زيادة نسبة تحلل الفيتات بزيادة فترة حضانة السن • التحميص له نتائج محدودة وخاصة عند خلطه بنسبة لا تزيد عن ٢٥ ٪ بينما اضافة الخميرة قبل التحضين لم يكن فعال فى خفض النسبة لكن تحضين السن لمدة ساعتين قبل اضافة الخميرة أعطى أعلى النتائج •

بالنسبة لصفات العجين : عند خلط السن الأحمر مع الدقيق زادت نسبة امتصاص الماء وزمن العجن وزمن الوصول والثبات ورقم الفالوريميتر وذلك بزيادة نسبة السن بينما انخفضت قيمة الضعف فى نفس الوقت دلت نتائج الاكستسوجرام أن اضافة السن تضعف قوة العجن وبالتالى تعطى خبز أقل حجما من المصنع من الدقيق بدون اضافات • وأظهرت النتائج أن أفضل نسبة خلط هى ٢٥ ٪ سن أحمر لاحتوائه على نسبة متوسطة من الألياف ومتوازن فى محتواه البروتين •