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PRODUCTION OF ENRICHED MACARONI AND PAN BREAD USING SOME SOURCES OF NUTRIENTS AND DIETARY FIBERS

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ABSTRACT: Vitamin B-group and iron as nutrients in addition to maltodextrine as a source of dietary fiber were designed as a group. The same components in addition to spinach , tomato , chicory leaves or carrot powders were designed as another group. These groups were evaluated to be used in the production of macaroni . It is found that 7% level of carrot powder and 5% levels of all other vegetable powders were a very suitable for producing enriched macaroni without affecting it's cooking quality and the overall acceptability . Enriched macaroni had more than the double content of dietary fiber as compared with the control .The added vegetable powders were the only source of vitamin A in the prepared macaroni . The cooking process caused a loss of about 50% of thiamin , 30% of riboflavine , 40% of nicotinic acid and 50% of vitamin A. The addition of the vegetable powders increased the calcium , magnesium , iron and zinc contents of the produced macaroni . Minerals and vitamins of enriched semolina were stable during storage of semolina for 3 months at room temperature (25 $\pm$ 2 C°).

Pan bread was made using vitamin B-group and iron as a group. It was also made using the same components in addition to carrot powder at 5% level as another group. There was no significant difference in the physical and the overall acceptability between the enriched pan bread and the control. The stability of vitamins and minerals in the enriched wheat flour (stored for 3 months) and the produced pan bread (stored for 3 days) at room temperature (25 $\pm$ 2 C°) was good.

INTRODUCTION

The nutrition profile of pasta fits well with current dietary guidelines recommended by many governments , medical and scientific organizations . These recommendations include choosing a diet high in complex carbohydrates . Pasta is a good source of complex carbohydrates , some essential vitamins and minerals . The nutritional value of pasta appears to be independent of the source of wheat flour used and is similar to other wheat based products . The most common additions to pasta are vitamins , minerals and vegetable powders (Ranhotra *et al.*, 1986 ; Mercier and Cantarelli , 1986 and USDA , 1989).

Unenriched pasta has relatively low levels of B-vitamins and iron . In USA , nearly all pasta products are systematically enriched with thiamin , riboflavin , nicotinic acid , and iron . Increased consumption of pasta and other grain products and increased allowances for enrichment have resulted in increased intakes of these nutrients contributed by grain products (Douglass and Matthews , 1982 ; Jenkins *et al.*, 1983 ; Cook and Welsh , 1987 and Fabriani and Claudia 1988). Public health measures such as the fortification of bread and pasta with iron and some B vitamins have markedly reduced the incidence of deficiency diseases that were once common (Mary and Mark, 1999).

Maltodextrins are non-sweet , nutritive (4 kcal / gm on a dry basis) mixtures of saccharines polymers of varying chain lengths and are produced by the acid and or enzymatic hydrolysis of corn starch . Maltodextrines act as a functional ingredients . they could increase viscosity , build soluble solids and contribute smooth mouthfeel in fat replacing systems for baked goods . An other important fact is that maltodextrins are GRAS (Deis , 1994 and Casimir , 1998). Fortification of foods such as bread and pasta with vitamin A has long been a practice in western countries. Foods that have been fortified with vitamin A for use in developing countries include wheat, rice and other grains products (Florentino *et al.*, 2000).

The leaves of chicory (*Chicorium intylus*) are higher in water and low in calories . Unbalanced (green) chicory leaves are an excellent source of vitamin A and potassium and moderately good source of calcium and vitamin C . Chicory leaves are useful to stimulate the flow of digestive juice and the movements of bowels (Ryder , 1979 Yamaguchi , 1983 and Gupta *et al.*, 1993).

Spanish got a high water content , low caloric value and protein content . It is an excellent source of vitamin A and a faire to good source of Vitamin (C) . It also contains about twice as much iron as other greens . Tomatoes also are high in water content , low in both calories and protein . They also are a good source of vitamin A and a faire source of vitamin C . Tomatoes dye , lycopene and other carotenoids had an anti-oxidant effect . Carrot roots contribute a significant portion of the daily requirement for vitamin A in diets . In additions to vitamins and minerals , carrots also provide important dietary fibers (Nicholson *et al.*,1985 , Lorenz and Maynard , 1988 ; Gould , 1992 ; Fordham , 1993 and Hadley , 1993 .

The present study is a trial to prepare enriched pasta with B-vitamins (thiamine , riboflavin , pantothinic acid and pyridoxine and iron . Maltodextrins , spanish , tomato , carrot and chicory leaves powders were also used as a good sources of functional fiber in addition to vitamins and minerals of these vegetables . The study was also aimed to produce pan bread fortified with B-vitamins, iron and carrot powder .

MATERIALS AND METHODS

1- Materials

B – vitamins (thiamine , riboflavin , niacin , pantothenic acid and pyridoxine (B_6) were all supplied by Roche Chemical Division, Hoffmann –la Rache Inc., ferrous sulfate (food grade) was obtained from sigma Chemical Co. (USA) . Maltodextrins was obtained from starch and glucose manufacturing Co. Cairo , Egypt.

Semolina and wheat flour (72 % extraction) were provided from Cairo Co. for Milling and Bakery , Cairo , Egypt .

Spanish ; tomato , chicory leaves and carrot were purchased from the local market.

2- Methods

Spanish and chicory leaves were steamed at 100 °C for 2 min and then rapidly cooled . They were dehydrated using air dryer at 60 °C until dryness , the samples were ground into fine powder and kept in polyethylene bags at 0 °C until used.

Carrot were cut into slides and put in a deep freezer at – 20 °C for 2 days and then kept at a forced draft oven at 60 °C until dryness .

Tomato were cut into slices and then dried at 60 °C as mentioned above .

The dried samples were ground at a particle size of 125 m.

Moisture , protein , ash , crude fiber , ether extract , total carbohydrate were determined as the methods described in A.O.A.C (1980). Total dietary fiber was determined as described in AACC (1980).

Zinc , Calcium , iron , magnesium were determined using Perkin-Elmer 23865 Atomic absorption spectro photometer (Germany).

Thiamine (B_1) was determined by photoflurometrically according to the thiochrome method described by Ellefson (1985) . Riboflavin (B_2) was determined as described by Jitendra (1985) by using a florometric method.

Niacin was determined by Ronald and Selwyn (1985) using colormetric method . Pantothenic acid was determined according to the method described by Michela and Lorenz (1976). One gm samples were extrated with papain and takadiastase at pH 4.5 for 24 hr at 39 °C . The samples were steamed , centrifuged and refrigerated until the assay with <u>*Lactobacillus plantarum*</u> AICC 8014 as the procedure outline by the AOAC (1980) and modified by walsh *et al.*, (1980). Pyridoxine (B_6) was determined using HPLC according to the methods described by Parrish (1977) and Egberg *et al.*, (1977).

The semonela used for macaroni and the flour used for pan bread were enriched with B-vitamins, iron, and partially replaced with different levels of maltodextrine and spinach, tomato, chicory leaves or carrot powder as shown in Table (1).

Preparation of macaroni

The enriched semolina is mixed in a dough mixer . Tab water is added to obtain a total water content of 32 – 33%. The dough is extruded in a pressure machine under vacuum at a pressure of 1.750 psi. Spaghetti of 1.7 mm thickness is then dried at 40 °C at decreasing relative humidity (from 90 to 60 in 20 hr). The final dried product contained 10 – 12 % moisture . For all cooking quality analysis, a standard method is used where 50 g of macaroni were poured into

Table (1): Fortification of semolina and flour with B-vitamins, iron, maltodextrine and different levels of spinach, tomato , chicory leaves and carrot powders .

Components	Macaroni products						Pan bread		
	control	Enriched control	2%	3%	5%	7%	control	Enriched control	With 10% carrot
Semolina	100	97	95	94	92	90	-	-	-
Flour	-	-	-	-	-	-	100	100	90
Thiamin*	-	1.13	1.13	1.13	1.13	1.13	-	0.55	0.55
Riboflavin*	-	0.49	0.49	0.49	0.49	0.49	-	0.40	0.40
Niacin*	-	8.25	8.28	8.25	8.25	8.25	-	7.87	4.87
Pantothenic acid*	-	0.41	0.40	0.40	0.40	0.40	-	0.42	0.42
Pyridoxine*	-	0.27	0.27	0.27	0.27	0.27	-	0.44	0.44
Iron*	-	3.69	3.69	3.69	3.69	3.69	-	-	-
Maltodexrine**	-	3.0	3.0	3.0	3.0	3.0	-	-	-
Spinach powder**	-	-	2.0	-	-	-	-	-	-
Tomato powder**	-	-	-	3.0	-	-	-	-	-
Chicory leaves powder**	-	-	-	-	5.0	-	-	-	-
Carrot powder**	-	-	-	-	-	7.0	-	-	10

* : mg/100 g ** : g/100 g

Table (2): Parameters and judgment values for macroni quality evaluation.

Stickiness, Bulkiness	Firmness	Over all rating	quality
None	Optimal Good Fair	10 9 8	Good
Average	Good Fair Low	7 6 5	Fair
High	Good Fair Low Very good	4 3 2 1	Low

500 ml boiling tap water . After 12 min , macaroni is removed from the boiling water , shaken and drained for 10 sec in a normal dripping vessel to remove excess water . The cooked macaroni was left undisturbed 9 – 10 min and then analyzed by a 10 panelists . The characteristics are stickiness , bulkiness (high or low tendency of macaroni to remain in mass . each element being more or less easily separated) and firmness (resistance to chewing) as shown in Table 2 (D'Egidio *et al.*, 1982).

Pan bread preparation:

Pan bread was prepared by sponge dough process according to the method described in AACC (1980). Dough were made with and without 10% of carrot powder vitamins, iron and for 25 min at 218 °C.

Calculation:

Initial nutrient values (added nutrients) were obtained by assaying for the nutrient contents for control (unfortified) samples and deducing these values from the assay values of the fortified samples.

% Retention was as follows:

% Retention =

$$\frac{Nutrient\ content\ of\ control\ sample}{Initial\ nutrient\ value} X100$$

Statistical analysis

Statistical analysis was applied for the data . ANOVA was carried out followed by multiple comparisons using LSD (Cochran,1960).

RESULTS AND DISCUSSION

The nutrient content of spinach, tomato , chicory leaves and carrot are shown in Table (3) for both fresh and powdered samples. The moisture content reduced from about 90% for fresh samples to about 6 – 7 % for dried powdered samples . Spinach powder had the highest protein content (27.57 %) and the lowest total carbohydrate content (42.51 %). Tomato powder had the highest values of both total carbohydrate content (61.16 %) and ether extract content (15.20%) but it had the lowest values of Ash content (10.4%) , crude fiber content (1.8%) and total dietary fiber content (16.23%) . Chicory leaves had the highest values of both crude fiber (10.4%) and total dietary fiber (48.41 %). Carrot powder had the highest value of ash content (30.9 %) and it had the lowest values of both protein content (7.17 %) and ether extract (1.72 %) .

The vitamins contents (mg/100 g, except vitamin A as IU) are also shown in Table (3). Spinach powder had the highest contents of both pyridoxine "B_6" (2.70 mg/100g) and vitamin A (53000 IU) but it had the lowest content of riboflavine (0.19 mg 100g). Tomato powder had the highest contents of both niacin (8.20 mg/100g) and pantothenic acid (2.97 mg/100g). Chicory leaves had the highest content of riboflavine (1.19 mg/100g) and it had the lowest content of pyridoxine "B_6" (0.56 mg 100g). Carrot powder had the lowest contents of thiamin (0.41 mg/100g), niacin (2.24 mg 100g) and vitamin A (9012 IU).

The minerals contents (mg/100g) are also presented in Table (3). Spinach powder had the highest contents of magnesium (870 mg/100g) , iron (30.2 mg/100g) and zinc (8.08 mg/100g). Tomato powder had the lowest contents of both calcium (98.2 mg/100g) and iron (4.31 mg/100g). Chicory leaves powder had the highest content of calcium (1205 mg/100g), while it had the lowest content of zinc (2.41 mg/100g). Carrot powder had the lowest content of magnesium (150.50 mg/100g). The values for fresh samples were also included for comparison.

Cooking quality, as indicated by cooked weight (the weight , gm obtained by cooking of 50 gm of raw macaroni) , volume and cooking loss (%) was determined for macaroni (control) and for macaroni enriched with vitamin B-group , iron and maltodextrine . Cooking quality was also determined for macaroni enriched with vitamin B-group, iron, maltodextrine and spinach, tomato, chicory leaves or carrot powders at 2 , 3 , 5 and 7 % levels using a standard cooking time of 12 min (Table 4). It could be concluded that macaroni could be enriched with vitamin B-group, iron and maltodextrine without affecting it's cooking quality. The addition of spinach, tomato or chicory leaves powders up to 5% level and the addition of carrot powder up to 7% level to the enriched macaroni did not affect it's cooking quality .

From table (4), it could be also seen that the enrichment of macaroni with vitamin B-group, iron and maltodextrine or with same components in addition to spinach, tomato or chicory leaves powders up to 5% level and carrot powder up to 7% did not affect the over all quality of the obtained macaroni as compared to the control . These results might be due to the maltodextrine (used at

3%) functionality . Maltodextrine had the ability of building solids and viscosity , binding water , so that the cooking quality of macaroni did not affect by the percentage of substitution (Deis, 1994 and Casimir 1998). From the data , it was shown that carrot powder could be used at higher levels than spinach, tomato and chicory leaves powders for enriched macaroni. This could be due to the higher pectin content in carrot. Pectin got the ability to bind more water and to build solids and viscosity (Zabik *et al.*, 1977). From the pervious data, the level of 5% was selected for spinach, tomato and chicory leaves powder while a level of 7% of carrot powder was selected for the production of macaroni to 5%, except enriched carrot macaroni to 7% level.

The nutrients contents of macaroni (control) and macaroni enriched with vitamin B-group, iron and maltodextrine or enriched with the same components in addition to spinach, tomato chicory leaves or carrot powders were presented in Table (5). It is shown that there is no difference in the proximate composition between the macaroni (control) and the enriched macaroni except that the enriched macaroni had a much higher (19.39%) dietary fiber content than the control (8.79%). However, the addition of vegetable powder to the enriched macaroni increased the dietary fiber contents. About 1% increase in protein content was obtained as a result of the addition of vegetable powders. As shown in the table, the cooking process increased the moisture contents of the macaroni by nearly 7 folds and decreased all the other components.

It is also shown in Table (5) that the enrichment of macaroni increased the vitamin B-group contents for all the enriched samples and the addition of vegetable powders caused a little increase in vitamin B-group contents. The data of vitamin A contents showed that the added vegetable powders were the only source of vitamin A in macaroni. The cooking process caused a loss of about 50% of thiamine , 30% of riboflavine, 40% of nicotinic acid and 50% of vitamin A. The addition of vegetable powders increased the calcium, magnesium, iron and zinc contents of the macaroni produced. Chicory leaves powder was contributed to the highest value (78.41 mg/100g) of calcium content of macaroni, followed by spinach (61.43) as compared with control (15.71) sample. Spinach powder contributed to the highest contents of magnesium (109.8) and iron (5.11) of produced macaroni as compared to the control (60.44 for magnesium and 0.61 for iron). The cooking process did not affect the mineral contents of macaroni. Cooking remained almost the same values especially enriched vegetables macaroni.

Stability of vitamins and minerals of enriched semolina (14.62% moisture content) is presented in Table (6). The stability of vitamins during storage for 3 months at room temperature was excellent and there was no loss in their contents. All added nutrients retained full potency even when the vegetable powders having high contents of minerals and vitamin A were added. The vitamin B-group. iron, maltodextrine and vegetable powders blended well with the semolina and produced a uniform product. The odor and appearance of the enriched semolina were the same as those of the unenriched semolina. These results are in agreement with that reported by (Cakirer and Lachance 1975), Judith (1982) and David (1993).

Pan bread was made using vitamin B-group and iron. It was also made using vitamin B-group , iron and carrot powder. The physical and organoleptic evaluation of the obtained pan bread was presented in Table (7) from which, it could be seen that there is no significant difference ($p>0.05$) in both weight (gm) and volume (cm^3) between both the control sample and the sample enriched with vitamin B-group and iron. While, the pan bread enriched with 5% of carrot powder in addition to vitamin B-group and iron had a higher weight (163.8 g) than both control (160.7 g) and the bread enriched with vitamin B-group and iron (160.5 g). This could be due to the ability of carrot powder to hold more water (Zabik *et al*., 1977). The enriched pan bread was slightly darker than the control. There was no significant difference ($p>0.05$) in taste between enriched and the control pan bread. The addition of carrot powder caused a significant difference ($p<0.05$) in gained score as compared to the control sample or the sample enriched with vitamin B-group and iron only. There was no significant difference ($p>0.05$) among all pan bread sample in the overall score.

The stability of vitamins and minerals in the enriched flours and pan bread was illustrated in Table

(8). The data showed a very good stability of vitamins and minerals during storage (for 3 months) of the enriched flours and also after baking and during storage of pan bread for 3 days at room temperature except some reduction of vitamin A in the case of pan bread made using carrot powder. There was no loss in minerals due to baking or due to storage of pan bread for 3 days.

The results are in agreement with those reported by Jorg Augustin *et al.*, 1982. It could be concluded that the use of vitamin B-group, iron, maltodextrine and vegetable powders could play a major role in improving the nutritional and the health benefits of such products like macaroni and bread without affecting their quality and acceptance.

Table (3) : Nutrient content of spinach tomatoes, chicory leaves and carrot of dible portions (fresh) and after dryness (powder).

Parameters	spinach		tomatoes		Chicory leaves		Carrot	
	Fresh	Powder	Fresh	Powder	Fresh	Powder	Fresh	Powder
Proximate composition :								
Moisture (%)	90.65	7.23	93.21	6.95	91.72	7.15	88.71	6.89
Protein (%)	3.37	27.57	0.76	13.24	1.61	21.35	0.73	7.17
Ash (%)	1.15	19.71	2.29	10.40	5.05	26.83	3.62	30.90
Crude fiber (%)	0.41	4.29	0.11	1.80	0.94	10.40	1.24	9.09
Total carbohydrate (%)	4.51	42.51	3.58	61.16	1.33	47.95	6.76	60.21
Ether extract (%)	0.32	10.21	0.16	15.20	0.29	3.87	0.18	1.72
Total dietary fiber (%)	2.40	24.52	1.01	16.23	3.77	48.91	2.62	22.36
Vitamins:								
Thiamine (mg/100 gm)	0.10	0.99	0.13	1.50	0.08	0.67	0.09	0.41
Riboflavine (mg/100 gm)	0.24	0.19	0.03	0.32	0.12	1.19	0.08	0.34
Niacin (mg/100 gm)	0.60	5.99	0.67	8.20	0.61	5.13	0.36	2.24
Pantothenic acid (mg/100 gm)	0.37	2.0	0.39	2.97	-	-	0.32	2.29
Pyridoxine (B_6) (mg/100 gm)	0.31	2.70	0.14	0.99	0.09	0.56	0.19	1.22
Vitamin A (iu)	8100	53000	1875	11900	4330	25000	1462	9012
Minerals:								
Calcium (mg/100 gm)	98	1011.0	9.91	98.20	108.10	1205.0	36.40	262.11
Magnesium (mg/100 gm)	91	870.0	13.41	160.66	34.11	371.0	19.80	150.50
Iron (mg/100 gm)	3.65	30.20	0.46	4.31	1.05	10.11	1.71	12.70
Zinc (mg/100 gm)	0.91	8.08	0.26	3.03	0.28	2.41	0.48	3.10

Table (4) : Cooking quality and quality evaluation of macaroni produced with maltodextrine , B-vitamins group and different levels of spinach , tomato, chicory leaves and carrot powders .

	Cooking quality			Quality evaluation			
	Cooked weight (gm)	Volume (cm^3)	Cooking loss (%)	Stickiness & bulkiness	Firmness	Overall rating	Quality
Macaroni (control)	161.00	139.00	4.92	10	10	20	G
Macaroni+ B-vitamins. group . iron and maltodextrine	161.5	140.00	4.90	10	10	20	G
Macaroni+ B-vitamins group ,iron , maltodextrine and vegetables powders of %							
Spinach powder							
2	161.79 a	140.5 a	4.93 a	10.0 a	10.0 a	20.0 a	G
3	161.85 a	141.0 a	4.95 a	9.8 a	10.0 a	19.8 a	G
5	162.25 a	143.5 a	4.95 a	9.0 a	9.1 a	18.1 b	G
7	160.61 b	138.5 b	5.02 b	8.1 b	8.7 b	16.8 b	F
L.S.D	0.63	3.61	0.06	0.71	1.02	1.22	-
Tomato powder							
2	162.4 a	141.0 a	4.95 a	9.8	9.9	19.7	G
3	160.3 a	140.0 a	4.97 a	9.6	9.7	19.3	G
5	159.9 a	140.5 a	4.91 a	9.5	9.3	18.8	G
7	150.2 b	122.0 b	4.99 ab	8.5	8.0	16.0	F
L.S.D	0.99	1.99	0.08	0.65	0.45	1.02	-
Chicory leaves							
2	163.40 a	145.0 a	4.72 a	10	10	20.0	G
3	163.00 a	145.0 a	4.75 a	10	9.9	19.9	G
5	163.15 a	145.0 a	4.75 a	9.5	9.5	19.0	G
7	159.00 b	135.0 b	5.21 b	8.0	8.0	16.0	F
L.S.D	1.00	1.55	1.21	0.67	0.81	0.75	-
Carrot powder							
2	167.50	150.0	4.25	10	10	20	G
3	166.71	149.0	4.21	10	10	20	G
5	166.60	149.5	4.20	9.9	9.8	19.7	G
7	166.51	149.3	4.25	10.0	9.9	19.9	G
L.S.D	N.S	N.S	N.S	N.S	N.S	N.S	-

G : good F : fairr L: low

a,b : There is no significant difference ($p>0.05$) between any two means have the same attributes for the same group.

Table (5). Nutrient content of enriched vegetables macaroni before and after cooking (as is / 100 gm).

Parameters	Control macaroni	Before cooking					After cooking				
		Enriched macaroni with B-vitamins group, iron, maltodextrine and with and without vegetables powder					Enriched macaroni with B-vitamins group, iron, maltodextrine and with and without vegetables powder				
		without vegetables	5% spinach	5% Tomato	5% chicory leaves	7% Carrot	Without vegetables	5% Spinach	5% Tomato	5% Chicory	7% Carrot
Proximate composition (%)											
Moisture	9.85	9.69	9.95	9.99	10.30	10.19	64.90	68.71	68.99	70.01	72.55
Protein	13.82	13.79	14.87	14.35	14.99	13.81	5.32	5.20	4.94	5.01	4.22
Ether extract	2.31	2.30	2.91	3.27	2.41	2.43	0.78	0.91	0.99	0.78	0.74
Ash	0.79	0.84	1.93	1.27	2.38	2.81	0.29	0.68	0.45	0.83	0.89
Crude fiber	1.26	1.28	1.54	1.17	1.95	2.31	0.48	0.50	0.43	0.71	0.71
Carbohydrate	73.23	73.41	70.34	71.12	69.92	70.76	28.71	24.50	24.20	23.37	21.60
Dietary fiber	8.79	19.39	21.31	20.42	24.71	20.91	8.91	11.51	10.22	15.98	10.98
Vitamins (mg/100 gm)											
Thiamine	0.03	1.00	1.02	1.04	1.02	1.04	0.20	0.18	0.17	0.16	0.15
Riboflavine	0.16	0.565	0.569	0.568	0.572	0.565	0.15	0.14	0.14	0.13	0.12
Niacin	0.40	7.81	8.39	8.10	7.99	7.93	1.83	1.75	1.67	1.61	1.45
Pantothinic acid	-	0.37	0.47	0.53	0.33	0.40	0.13	0.15	0.16	0.10	0.11
Pyridoxine	-	0.13	0.29	0.25	0.24	0.22	0.04	0.09	0.07	0.07	0.06
V.A (IU)	-	-	2130	729	1010	639	-	960.0	357	550	280
Minerals (mg/100 gm)											
Calcium	15.71	15.32	61.34	21.31	78.41	32.88	5.75	21.21	7.31	26.01	9.85
Magnesium	60.44	60.66	109.80	66.41	77.21	64.11	13.57	30.05	13.87	19.81	10.54
Iron	0.61	3.98	5.11	3.99	4.15	4.21	1.01	1.27	1.00	0.81	0.78
Zinc	1.10	1.02	1.25	1.15	1.22	1.31	0.37	0.40	0.35	0.36	0.37

Table (6) : Stability of vitamins and minerals (in mg/100 g) of enriched semolina.

Semolina samples *	Levels of enrichment	Initial content	Contents after 3 month	% Retention
Semolina with B- vitamins group and iron				
Thiamine	1.13	1.19	1.17	98.3
Riboflavin	0.49	0.61	0.61	100.0
Niacin	8.25	8.59	8.57	99.8
Pantothinic acid	0.41	0.40	0.38	95.0
Pyridoxine	0.27	0.31	0.32	103.0
V.A. (Iu)	-	-	-	-
Iron	3.69	4.31	4.29	99.5
Calcium	-	16.40	16.40	100.0
Magnesium	-	63.41	63.40	100.0
Zinc	-	1.07	1.01	94.4
Semolina with B- vitamins group , iron, maltodextrine and 5% spinach powder				
Thiamine	1.13	1.21	1.19	98.3
Riboflavin	0.49	0.63	0.60	95.2
Niacin	8.25	8.80	8.75	99.4
Pantothinic acid	0.41	0.54	0.52	96.3
Pyridoxine	0.27	0.33	0.33	100.0
V.A. (Iu)	-	2599	2390	9109
Iron	3.69	5.36	5.32	99.2
Calcium	-	64.41	64.42	100.0
Magnesium	-	115.29	115.26	102.1
Zinc	-	1.31	1.29	98.5

*: contained 14.62% moisture

Continue of Table (6) .

	Levels of enrichment	Initial content	Contents after 3 mounth	% Retention
Semolina with B- vitamins group and iron, maltodextrine and 5% tomato powder				
Thiamine	1.13	1.20	1.21	100.8
Riboflavin	0.49	0.65	0.65	100.0
Niacin	8.25	8.60	8.60	100.0
Pantothinic acid	0.41	0.61	0.59	96.7
Pyridoxine	0.27	0.32	0.30	93.8
V.A. (Iu)	-	868	690	79.5
Iron	3.69	4.32	4.28	99.1
Calcium	-	22.40	22.36	99.8
Magnesium	-	69.78	69.70	99.9
Zinc	-	1.19	1.18	99.2
Semolina with B- vitamins group, iron,	-			
maltodextrine and 5% chicory leaves		1.17	1.15	98.3
Thiamine	1.13	0.60	0.65	98.5
Riboflavin	0.49	9.00	9.02	100.2
Niacin	8.25	0.46	0.45	97.8
Pantothinic	0.41	0.31	0.30	96.8
Pyridoxine	0.27	1311	1170	89.2
V.A. (Iu)	-	4.36	4.32	99.1
Iron	3.69	82.33	82.30	99.9
Calcium	-	81.00	80.65	99.6
Magnesium	-	1.28	1.29	100.8
Zinc	-			
Semolina with B- vitamins group, iron, maltodextrine and 7% carrot powder				
Thiamine	1.13	1.22	1.20	98.4
Riboflavin	0.49	0.65	0.65	100
Niacin	8.25	9.21	9.22	100.1
Pantothinic	0.41	0.49	0.45	91.8
Pyridoxine	0.27	0.33	0.32	97.0
V.A. (Iu)	-	620	498	80.3
Iron	3.69	4.44	4.40	99.1
Calcium		34.52	34.55	100.1
Magnesium	-	67.31	67.30	100.0
Zinc	-	1.37	1.35	98.5

Table (7) : Physical and organolyptic evaluation of enriched pan bread

Aspects	Control	Enriched* pan bread	Enriched** pan bread made with 5% carrot powder	L.S.D
Loaf weight (gm)	160.7 b	160.5 b	163.8 a	2.51
Loaf volume (cm^3)	460 a	460 a	459.0 a	1.30
Specific volume (cm^3/gm)	2.88 a	2.87 a	2.78 a	0.30
Crumb color (10)	9.8 a	9.3 b	9.0 c	0.25
Grain (10)	9.8 a	9.3 b	9.0 b	0.55
Taste (10)	10.0 a	10.0 a	9.9 a	0.39
Overall scores (Mean)	9.8 a	9.3 a	9.0 a	0.93

* Using vitamins B-group and iron .

** Using vitamins B-group , iron and 5% carrot powder.

a,b : There is no significant difference ($p>0.05$) between any two means have the same letter with the same attribute.

Table (8) : Stability of vitamins and minerals (mg/100 g) in enriched flour and pan bread

Components	Flour				Pan bread			
	Levels added	Initial content	After 3 month	% Retention	After baking	% Retention	After 3 days	% Retention
Flour with B- vitamins group and iron								
Thiamine	0.55	0.64	0.63	98.4	0.62	98.4	0.62	100.0
Riboflavine	0.40	0.42	0.42	100.0	0.40	95.2	0.39	97.5
Niacin	4.87	5.07	4.96	97.8	4.90	98.8	4.89	99.8
Pantothinic acid	0.42	0.42	0.40	95.2	0.37	92.5	0.37	100.0
Pyridoxine	0.44	0.46	0.45	97.8	0.42	93.3	0.41	97.6
V.A. (Iu)	-	-	-	-	-	-	-	-
Iron	5.9	6.3	6.35	100.7	6.30	99.2	6.3	100
Calcium	-	8.0	8.00	100.0	8.00	100	8.0	100
Magnesium	-	3.0	3.00	100.0	3.00	100	3.0	100
Zinc	-	0.1	0.09	90.0	0.09	100	0.09	100
Flour with B-vitamins group , iron, and 5% carrot powder								
Thiamine	0.55	0.69	0.69	100	0.68	98.5	0.67	98.5
Riboflavine	0.40	0.43	0.43	100	0.39	90.7	0.38	97.4
Niacin	4.87	5.10	5.00	98	4.98	99.6	4.98	100.0
Pantothinic acid	0.42	0.49	0.48	97.9	0.47	97.9	0.47	100.0
Pyridoxine	0.44	0.49	0.47	95.9	0.46	97.9	0.45	97.8
V.A. (Iu)	-	1011	850	84.1	675	79.4	490	79.0
Iron	5.9	6.8	6.8	100.0	6.7	98.5	0.65	99.2
Calcium	-	29.0	29.0	100.0	28.8	99.3	28.8	100.0
Magnesium	-	18.0	18.0	100.0	18.0	100	18.0	100.0
Zinc	-	0.13	0.1	76.9	0.09	90.0	0.085	94.4

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إنتاج مكرونة و خبز افرنجي مدعمين ببعض المغذيات و الألياف الغذائية

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تم استخدام مجموعة فيتامين ب (الثيامين – الريبوفلافين – النياسين – حامض البانتوثينيك – البيرودوكسين) و الحديد بالإضافة إلى استخدام المالتودكسترين كمصدر للألياف الغذائية – كما تم استخدام هذه المواد السابقة بالإضافة إلى استخدام مسحوق السبانخ أو الطماطم أو أوراق الشيكوريا أو الجذر كمصدر لفيتامين أ و الألياف الغذائية و ذلك لإنتاج مكرونة .

– وجد أن استخدام ٧% من مسحوق الجذر و ٥% من مسحوق الطماطم و السبانخ و أوراق الشيكوريا قد أعطت منتج مكرونة مدعم ذو صفات جديدة و دون التأثير على صفات الطبخ للمكرونة بعد تصنيعها – بالإضافة إلى تضاعف كمية الألياف الغذائية بالمقارنة بالعينة الكنترول .

– أدت عملية الطبخ إلى فقد حوالي ٥٠ % من الثيامين ، ٣٠ % من الريبوفلافين ، ٤٠ % من حامض النيكوتينيك ، ٥٠ % من فيتامين (أ).

– أدى استخدام مسحوق الخضروات إلى جانب أنها مصدر الفيتامين (أ) إلى زيادة الكالسيوم – الماغنسيوم ، الحديد و الزنك في منتج المكرونة .

– كانت الفيتامينات و المعادن الموجودة بالسيمولينا المدعمة ثابتة أثناء التخزين لمدة ٣ شهور على درجة حرارة الغرفة (٢٥ ± ٢م°) .

– تم إنتاج خبز افرنجي باستخدام مجموعة فيتامينات ب و الحديد كما تم إنتاج الخبز باستخدام مجموعة فيتامينات (ب) و الحديد و ٥ % من مسحوق الجذر كمصدر لفيتامين (أ) . و قد أظهرت النتائج عدم وجود اختلافات معنوية بين الخبز المدعم و الخبز الكنترول من ناحية صفات الجودة .

– وجد أن محتوى الفيتامينات و المعادن في دقيق القمح المدعم و المخزن لمدة ٣ شهور على درجة حرارة الغرفة و كذلك بالنسبة للخبز المدعم و المخزن لمدة ٣ أيام كان ثابتا تقريبا.