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EFFECT OF SOME BY – PRODUCTS RICH IN DIETARY FIBER ON COOKING QUALITY ,NUTRITIONAL VALUE AND ORGANOLEPTIC CHARACTERISTICS OF COOKED SPAGHETTI

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ABSTRACT

Different sources of by-products rich in dietary fiber (D.F) *i.e.* wheat bran, shorts, rice bran, defatted rice bran, okara, defatted okara and apple pomace were separately added to semolina. The formulated blends were evaluated for their chemical composition, cooking quality, nutritional value and organolyptic characteristics. Results showed that all of the added cereal by-products increased the weight and volume of the produced spaghetti compared to control. All blends containing by-products rich in dietary fiber caused a higher loss in total soluble solids (T.S.S) in cooking water compared to control. Addition of these by - products up to 3% dietary fiber caused no effect on the shear force of the cooked spaghetti, while it was decreased at 5.7 and 10%D.F.The lightness values for all uncooked spaghetti were decreased as the percentage of dietary fiber increased. Results also showed that the addition of these by-products decreased the carbohydrate and protein contents of the produced spaghetti. No significant difference in the organoleptic characteristics of spaghetti processed from semolina or those containing (3% D.F) were obtained. However highly significant differences were found in the other replacements. It could also be concluded that the addition of shorts (up to7%D.F.)to semolina showed a good quality characteristics for

weight and volume increase, lowest cooking loss, high nutritional value (protein digestibility and total calories) and organoleptic properties of blends of semolina with either wheat bran or defatted okara (at 5% dietary fiber replacement).On the other hand, semolina with either rice bran or defatted rice bran showed the lowest quality characteristics at any percentage of replacement.

Key words: *cooking quality, dietary fiber, nutritional value, sensory evaluation, spaghetti.*

1.INTRODUCTION

Cereal and cereal products are widely consumed as a source of energy as well as protein intake. Macaroni as a major source of carbohydrates is produced by using semolina, durum wheat farina, or any combination of two or more. Semolina of durum wheat is considered an ideal raw material for such production.

In Egypt, macaroni is produced by using wheat flour 72% extraction and semolina. Because of the high prices of the imported semolina, Egyptian durum wheat (Sohag 2) is grown in Sohag Governorate and used for macaroni production.

Different attempts have been tried to replace part of semolina with either legume (to raise protein content) or fiber rich sources. Cummings, (1978) and Anderson and Chen (1979) stated that cereal fibers exerted a pronounced effect on the colon, in which it decreases the transit time of the digestible materials. Gel-forming polysaccharides alter the pattern of glucose absorption and may be hypocholestrolemic. Insoluble plant fibers appeared to be ineffective in lowering serum cholesterol.

It is reported that the healthy diet, should be low in fat and high in dietary fibers to prevent and control the diet-related diseases such as coronary heart disease, diabetes, bowel disorders and some cancers (Carrol, 1990 and Hong *et al.,* 1993).It is also found that noodles made with 5% treated soymilk residue received the highest sensory score. In addition, the textural properties of noodles supplemented with 10% treated soymilk residue or 5% treated apple pomace were similar to those of control (wheat flour noodles).

Abo El-Naga (1995) reported that addition of dietary fiber rich sources (*i.e.,* potato peels , maize pith , sugarcane pith and alpha cellulose) increased the cooking loss and cooked weight and volume in the produced spaghetti .

The present work was carried out to study the effect of some dietary fiber rich sources *i.e.*, (wheat bran, shorts, rice bran, defatted rice bran, okara, defatted okara and apple pomace) on the cooking quality, nutritional value and sensory evaluation of the produced spaghetti.

2.MATERIALS AND METHODS

2.1. **Semolina** [Obtained from the Egyptian Company for macaroni and starch (Regina), EL- Sadat City, Egypt.], **Wheat bran and shorts** [obtained from South Cairo Mills Company, Giza, Egypt], **Rice bran and defatted rice bran** [obtained from Rice Technology and Training Center at Sakha, Agriculture Research Center, Egypt], **okara** (soymilk residue) [obtained from the Agriculture Research Center, Giza] and **apple pomace** [the residue after extraction of apple juice (Anna apples)] were used.

2.2. **Preparation of different dough blends of spaghetti.** Different spaghetti dough blends were prepared by partial replacement of semolina with different levels of dietary fiber rich sources. *i.e.* wheat bran ,shorts, rice bran , okara , defatted okara and apple pomace. The addition was based on the percentage of dietary fiber in each source and calculated to be 3, 5, 7 and 10% as shown in Table (1).

2.3. Processing of spaghetti: - Spaghetti was processed in the semi-commercial scale laboratory extruder (De Francis Machine Corporation), according to the method described by Dexter and Matsuo (1977).

2.4. Cooking quality of spaghetti:-The cooking quality *i.e.* the percentage increase in weight and volume and cooking loss were measured using the method described by Walsh and Gilles (1971).Color and firmness of the cooked spaghetti were measured according to the methods of Hunter(1958)and Walsh (1971),respectively. The cooking time was10 min in boiling water.

Table (1): Different blends containing semolina and other dietary fiber rich sources

Sample No	Semolina	Wheat bran	Shorts	Rice bran	Defatted rice bran	Okara	Defatted okara	Apple Pomace	%of* T.D.F
1	100.00	-	-	-	-	-	-	-	5.7
2	93.67	6.33	-	-	-	-	-	-	3
3	89.45	10.55	-	-	-	-	-	-	5
4	85.23	14.77	-	-	-	-	-	-	7
5	91.81	-	8.19	-	-	-	-	-	3
6	86.35	-	13.65	-	-	-	-	-	5
7	80.89	-	19.11	-	-	-	-	-	7
8	72.70	-	27.30	-	-	-	-	-	10
9	91.98	-	-	8.02	-	-	-	-	3
10	86.62	-	-	13.38	-	-	-	-	5
11	81.27	-	-	18.73	-	-	-	-	7
12	93.20	-	-	-	6.80	-	-	-	3
13	88.66	-	-	-	11.34	-	-	-	5
14	84.12	-	-	-	15.88	-	-	-	7
15	91.25	-	-	-	-	8.75	-	-	3
16	85.41	-	-	-	-	14.59	-	-	5
17	79.57	-	-	-	-	20.43	-	-	7
18	70.82	-	-	-	-	29.18	-	-	10
19	92.01	-	-	-	-	-	7.99	-	3
20	86.68	-	-	-	-	-	13.32	-	5
21	81.35	-	-	-	-	-	18.65	-	7
22	95.65	-	-	-	-	-	-	4.35	3
23	92.74	-	-	-	-	-	-	7.26	5
24	89.83	-	-	-	-	-	-	10.17	7
25	85.47	-	-	-	-	-	-	14.53	10

*** T.D.F: % addition of by-product based on its content of dietary fibers.**

2.5. Determination of protein digestibility (*In vitro*). Protein digestibility (*In vitro*) was assessed by using pepsin and pancreatin as described by Villegas *et al.*, (1968) and Micro Kjeldahel methods (A.O.A.C. , 1990) . Percentage of protein digestibility was calculated by using the following equation

$$\text{Protein digestibility \%} = \frac{\text{Digested protein in supernatant} \times 100}{\text{protein content of sample}}$$

2.6. Caloric value. Total caloric values of cooked spaghetti were calculated according to Dougherty *et al.*, (1988).

2.7. Sensory evaluation: Appearance, color, flavor, tenderness, and stickiness of the cooked spaghetti were organoleptically evaluated as described by Matz (1969). The obtained data were statistically analyzed using analysis of variance and least significant range (L.S.R.) (Waller and Duncan,1969).

3.RESULTS AND DISCUSSION

3.1.Chemical composition of cooked spaghetti blends

Results in Table (2) show that the spaghetti blends of semolina supplemented with apple pomace possessed the highest loss in carbohydrates, while spaghetti blends of semolina with defatted okara had the highest loss in protein content. However, spaghetti blends of semolina with shorts had the lowest loss in carbohydrates and protein content. In addition semolina and wheat bran blend had the highest loss in total lipid, while the lowest loss was for semolina with okara. It was found that addition of okara decreased the loss in crude fiber while the ash loss was increased in blends of semolina with defatted rice bran.

From the above results it could be concluded that cooking of spaghetti caused some loss in the chemical constituents of the cooked spaghetti. Such loss varied according to the replacement percentage and composition of the blends. Addition of wheat bran to semolina decreased the loss in carbohydrates followed by shorts, rice bran and okara, respectively. On the other hand, addition of shorts to semolina decreased the loss in protein followed by wheat bran, rice bran and

Table (2): Effect of cooking in boiling water for 10 minutes on the chemical composition of cooked spaghetti (on dry weight basis).

Spaghetti Sample	% D.F*	Carbohydrates		Protein		Total lipid		Crude fiber		Ash	
		Before cooking	After cooking	Before cooking	After cooking	Before cooking	After cooking	Before cooking	After cooking	Before cooking	After cooking
Semolina		82.38	76.05	14.65	14.33	1.19	0.87	1.17	0.93	0.69	0.55
	%loss		7.68		2.18		26.89		20.51		20.28
Semolina + wheat bran	3%	81.36	75.07	14.59	14.13	1.36	0.98	1.73	1.08	1.00	0.86
	Loss		7.68		3.15		27.94		34.68		25.00
	5%	80.69	74.48	14.54	14.07	1.48	1.09	2.11	1.38	1.21	0.92
	%loss		7.69		3.23		26.75		34.59		23.96
	7%	80.03	73.59	14.49	13.96	1.60	1.19	2.49	1.61	1.42	1.06
	%loss		8.04		3.65		25.62		35.34		23.96
Semolina + shorts	3%	81.70	75.57	14.53	14.22	1.35	1.08	1.59	1.27	0.87	0.69
	%loss		7.50		2.13		20.00		20.12		20.68
	5%	81.25	74.68	14.46	14.02	1.46	1.16	1.88	1.36	0.99	0.74
	%loss		8.08		3.04		20.54		27.65		25.25
	7%	80.81	74.25	14.38	13.94	1.57	1.25	2.16	1.57	1.11	0.82
	%loss		8.11		3.05		20.38		27.31		26.12
	10%	80.12	73.45	14.27	13.73	1.74	1.39	2.59	1.96	1.30	0.94
	%loss		8.32		3.78		20.11		24.32		27.69
Semolina + ricebran	3%	80.35	73.61	14.30	13.73	2.54	1.98	1.72	1.35	1.13	0.81
	%loss		8.38		3.98		22.04		21.51		28.31
	5%	79.00	72.28	14.07	13.49	3.45	2.47	2.09	1.62	1.42	1.03
	%loss		8.50		4.12		28.40		22.48		27.46
	7%	77.66	70.42	13.85	13.16	4.34	2.94	2.46	1.83	1.73	1.20
	%loss		9.32		4.98		32.25		25.60		30.63
Semolina + defatted rice bran	3%	81.21	74.01	14.47	13.91	1.33	0.97	1.69	1.21	1.32	0.81
	%loss		8.86		3.87		27.06		28.40		38.63
	5%	80.44	72.60	14.35	13.42	1.444	1.01	2.03	1.52	1.75	1.06
	%loss		9.02		6.48		29.86		25.12		39.42
	7%	79.68	71.58	14.24	13.10	1.54	1.09	2.38	1.74	2.18	1.30
	%loss		10.16		8.05		29.22		26.89		40.69
Semolina + okara	3%	79.38	72.25	15.84	15.17	2.08	1.80	1.36	1.19	1.45	1.13
	%loss		8.98		4.22		13.46		12.50		22.06
	5%	77.38	9.53	16.65	15.71	2.69	2.20	1.49	1.24	2.38	1.85
	%loss		10.14		5.64		18.21		16.77		22.26
	7%	75.38	67.75	17.45	16.46	3.29	2.69	1.63	1.36	2.25	1.76
	%loss		10.12		5.67		18.23		16.56		21.77
	10%	72.39	65.03	18.66	17.58	4.20	3.42	1.82	1.50	2.93	2.29
	%loss		10.16		5.78		18.57		17.58		21.84
Semolina + defatted okara	3%	80.00	73.31	15.995	15.21	1.33	10.06	1.37	1.10	1.36	1.06
	%loss		8.36		7.40		20.30		19.70		22.05
	5%	78.40	71.29	16.83	15.62	1.44	1.13	1.51	1.19	1.81	1.40
	%loss		9.06		7.18		21.52		21.19		22.65
	7%	76.85	69.08	17.71	16.40	1.53	1.18	1.65	1.29	2.27	1.74
	%loss		10.11		7.39		22.87		21.52		23.34
Semolina + apple pomace	3%	81.59	73.91	14.41	13.58	1.444	1.14	1.73	1.38	0.85	0.67
	%loss		9.41		5.75		20.83		20.23		21.17
	5%	81.07	72.76	14.25	13.30	1.61	1.23	2.11	1.60	0.94	0.70
	%loss		10.25		6.66		23.60		24.17		25.53
	7%	80.55	71.88	14.14	13.19	1.78	1.31	2.50	1.89	1.08	0.80
	%loss		10.76		6.71		26.40		24.40		25.92
	10%	79.78	70.94	13.87	12.93	2.04	1.50	3.07	2.30	1.26	0.93
	%loss		11.08		6.77		26.47		25.08		26.19

* D.F: Dietary fiber

defatted rice bran, while the highest loss was in spaghetti made from semolina and defatted okara (at 5% D.F. replacement).

Such effects could be attributed to the chemical constituents of blend ingredients in which cereal by-products contained the highest amount of starch and could be also considered rich in protein and crude fibers .Meanwhile, okara and defatted okara are characterized by the highest content of protein and the lowest content of starch. Whereas, apple pomace is characterized by high contents of crude fibers and fat and had the lowest content of protein.

3.2. Cooking quality of ppaghetti

Different spaghetti blends prepared by partial replacement of semolina with different byproducts rich in dietary fibers *i.e.* wheat bran, shorts, rice bran, defatted rice bran, okara, defatted okara and apple pomace were evaluated for cooking quality *viz.*, weight and volume increase and cooking loss (determined as changes in T.S.S). Firmness and color were also evaluated and results are presented in Tables (3 and4).

3.2.1. Weight and volume of the cooked spaghetti

Results in Table (3) show that the addition of byproducts rich in dietary fibers caused an increase in weight and volume of the cooked spaghetti for all samples compared to control . Addition of cereal byproducts revealed that shorts caused the highest increase in weight and volume of cooked spaghetti followed by wheat bran then defatted rice bran and rice bran, in that order. Spaghetti, replacement with okara, defatted okara and apple pomace had almost the same increase in weight and volume and still higher than control.

So, it could be concluded that the high increase in weight and volume for spaghetti containing cereal byproducts could be attributed to their high content of starch and cellulose. On the other hand, the increased weight and volume for spaghetti containing okara, defatted okara and apple pomace could be attributed to the high soluble dietary fibers that caused an increase in their swelling power. These results are in agreement with those obtained by Dexter *et al.*, (1994), who reported that good quality macaroni products should absorb water at least twice of their original volume. They also repored that

Table (3) : Cooking loss (T.S.S) & weight and volume and firmness of different cooked spaghetti .

Spaghetti blend	Dietary fibers	Cooking loss (T.S.S) after cooking for:			Weight and volume of cooked spaghetti				Firmness (g/cm)
		5 minutes	10 minutes	15 minutes	Volume	±%	Weight	±%	
Semolina		5.98	7.27	8.60	193.7	-	275	-	31
Semolina + wheat brbran	3%	6.52	7.91	9.6	199.5	2.99	281	2.18	31
	5%	6.71	8.06	9.79	207.2	6.86	301	9.45	28
	7%	7.07	8.57	10.13	215.5	12.80	311	13.09	27
Semolina + shorts	3%	6.60	7.17	9.10	211.3	9.08	296	7.63	32
	5%	7.48	8.04	10.03	220.6	13.88	319	16.0	30
	7%	7.78	8.15	11.12	229.4	18.43	326	18.54	29
	10%	7.91	8.52	11.19	232.1	19.82	333	21.09	27
Semolina + rice bran	3%	6.44	8.53	10.14	194.9	0.61	281	2.18	31
	5%	8.21	9.11	12.21	204.7	5.67	290	5.45	29
	7%	9.61	10.57	13.14	212.6	9.75	296	7.63	26
Semolina + defatted rice bran	3%	6.81	9.11	10.94	200.2	3.35	287	4.36	30
	5%	8.22	10.61	12.43	206.7	6.71	293	6.54	29
	7%	9.83	11.21	13.13	215.3	11.15	299	8.72	27
Semolina + okara	3%	6.19	8.46	10.72	206.1	6.40	295	7.27	34
	5%	7.44	9.42	11.03	211.4	9.13	304	10.54	31
	7%	7.98	9.8	11.61	219.0	13.06	317	15.27	30
	10%	8.31	10.11	12.61	225.0	16.15	320	16.36	29
Semolina + defatted okara	3%	6.80	8.26	10.81	210.4	8.62	295	7.27	33
	5%	7.31	9.33	11.21	217.0	12.02	316	14.90	30
	7%	8.39	10.31	13.12	223.0	15.12	325	18.18	29
Semolina + apple pomace	3%	6.81	9.31	12.41	198.5	2.47	297	8.00	31
	5%	18.12	10.41	12.73	207.0	6.86	300	9.09	30
	7%	8.43	10.93	13.91	216.0	11.51	315	14.54	29
	10%	8.94	11.31	14.44	222.0	14.61	320	16.36	28

the cooked weight and volume of substituted spaghetti were higher than those of control. Abo El-Naga (1995) found that the cooked weight and volume of substituted spaghetti samples increased as the addition of dietary fiber increased.

3.2.2.The cooking loss

It is known that the quality of the cooked spaghetti is greatly affected by the amount of total soluble solids (T.S.S) lost in the cooking water. Therefore, the spaghetti samples were cooked for 5, 10 and 15 minutes and T.S.S. were determined in the cooking water as presented in Table (3).

Results in Table (3) show that the loss in T.S.S. during cooking of mocaroni increased by the addition of the studied byproducts compared to control. In addition T.S.S. also increased by increasing the amount of byproducts added.

The variation in T.S.S. loss during cooking of macroni could be attributed to the varied chemical composition of dietary fiber sources. It was also found that the increase in weight and volume of the cooked macaroni varied according to the type and chemical constituents of the added byproducts. These results are in agreement with those of Kordonowy and Youngs,(1985)who reported that wheat bran containing spaghetti samples had higher cooking losses that could be attributed to the high content of water soluble components.

3.2.3.Firmness(as shear force) of spaghetti

Results in Table (3) show that spaghetti substituted with by-products rich in dietary fibers (up to 3%) showed no effect on their firmness after cooking . Moreover, the firmness of cooked spaghetti decreased by the increasing of dietary fibers which could be attributed to the diluting effect of fibers on gluten cohesiveness (Kordonowy and Youngs, 1985). On the other hand, results show that addition of okara and defatted okara at 3% caused an increase in shear force of the processed spaghetti. Such increase might be attributed to their protein content which improved the cohesiveness of the dough. These results agreed with those of Bahnassey and Khan (1986) and Duszkiewicz – Reinhard *et al.*, (1988) who reported that spaghetti firmness was improved with increasing protein content.

3.2.4. Spaghetti color

Color, is the most important quality parameter of spaghetti, and was determined for the studied blends and the results are presented in Table (4). Results indicated that the lightness values (L) of uncooked spaghetti decreased as the percentage of dietary fiber increased. It is also noticed that spaghetti processed from semolina only (control) had the highest value of lightness (78.1) compared with the other studied blends. Results also showed that the lightness values (L) for all samples decreased by cooking. The cooked spaghetti samples showed lower lightness values compared to uncooked ones. Defatted okara and okara spaghetti blends showed high lightness values compared with the studied blends. However, addition of apple pomace greatly affected the lightness of the produced spaghetti which possessed a clear brown color compared to the control and other samples. This could be attributed to the phenolic compounds present in apple pomace and their action in increasing the browning process. The results also indicated that cooking of spaghetti in boiling water for ten minutes reduced the lightness (L) and yellowness(b) values for all treatments and varied according to the dietary fiber source added.

3.3. Nutritional value of cooked spaghetti

3.3.1.Protein digestibility (*in vitro*).

From the data given in Table (5) it is clear that cooked spaghetti substituted with either shorts (7% D.F) or apple pomace (7%D.F) had higher values of protein digestibility(*In vitro*) compared to other samples. Results revealed also that at all level of replacement (semolina with wheat bran, shorts , rice bran , defatted rice bran , okara, defatted okara and with apple pomace), cooking of the spaghetti improved protein digestibility (*in vitro*) as compared to uncooked spaghetti. These results are in agreement with those reported by Maneepun (1978) who found that the addition of corn bran in the preparation of spaghetti gave good digestibility and the highest fecal weight.In this respect, the lowest value(113.23k cal) of total calories was for cooked spaghetti substituted with defatted okara (at 5% dietary fiber) compared to other samples(at the same level of dietary fiber).From the same results, the total calories of the spaghetti blends could be arranged in a descending order as follows:

Table (4): Hunter color values* of uncooked and cooked spaghetti.

Spagheti blends	D.F**	Uncooked spaghetti			Cooked spaghetti		
		L	A	B	L	A	b
Semolina		78.1	2.1	19.8	78.3	-2.8	21.3
Semolina + wheat bran	3%	76.4	3.5	18.1	67.9	1.6	13.8
	5%	75.4	3.4	18.0	67.8	0.7	13.5
	7%	73.8	2.7	17.6	67.5	0.1	13.2
Semolina + shorts	3%	76.0	2.6	19.4	71.6	-0.1	17.1
	5%	75.1	2.2	19.3	70.5	0.2	16.3
	7%	74.9	1.9	18.9	69.8	0.5	15.7
	10%	73.2	1.6	17.4	68.1	0.7	15.1
Semolina +rice bran	3%	73.1	2.1	18.9	70.5	-0.1	15.2
	5%	71.2	2.0	18.0	67.0	1.2	14.7
	7%	69.4	1.6	17.5	66.89	1.6	14.0
Semolina + D*. rice bran	3%	72.2	2.4	18.0	66.9	1.3	13.1
	5%	70.4	1.8	17.8	66.3	1.2	12.5
	7%	69.8	1.4	17.6	65.5	0.9	11.8
Semolina + okara	3%	74.5	2.4	20.7	71.4	-2.2	18.1
	5%	74.1	2.3	19.9	70.1	-2.0	17.2
	7%	73.8	1.6	19.2	69.3	-1.9	17.0
	10%	72.6	1.4	18.6	68.1	-1.4	16.7
Semolina + D*. okara	3%	77.9	2.1	20.0	72.2	-2.6	18.8
	5%	77.0	2.6	19.0	71.3	-2.1	17.6
	7%	76.5	2.7	18.4	71.0	-1.7	17.4
Semolina + apple pomace	3%	75.6	2.3	17.4	62.1	3.0	13.6
	5%	74.1	2.1	16.9	61.4	2.8	13.1
	7%	73.9	1.6	16.9	60.3	2.4	12.4
	10%	70.2	1.4	15.4	58.7	2.0	12.0

*D: defatted

** D.F.: dietary fibers

♣Hunter color values: (L = Lightness; a = + red, - green; b= yellow, - blue).

semolina, semolina with rice bran, defatted rice bran, wheat bran, okara, apple pomace, shorts and defatted okara.

3.3.2.Total calories in cooked spaghetti

Total calories present in a known weight (100gm) of the studied samples varied according to the added dietary fiber source and level of addition. Total calories given for the studied samples decreased as the level of added dietary fibers increased (Table 5). In this respect, the lowest value(113.23kcal) of total calories was for cooked spaghetti substituted with defatted okara (at 5% dietary fiber) compared to other samples(at the same level of dietary fiber).From the same results, the total calories of the spaghetti blends could be arranged in a descending order as follows: semolina, semolina with rice bran, defatted rice bran, wheat bran, okara, apple pomace, shorts and defatted okara. The results agreed with those reported by Lockhart *et al.,* (1980) who found that the caloric content of a food is related to its available carbohydrate content. Therefore a high dietary fiber level tended to reduce the caloric value of a food.

3.3.3.Organoleptic properties of spaghetti

The organoleptic properties of processed spaghetti with semolina and different blends were evaluated (Table 6). No significant difference in the appearance of spaghetti processed from semolina or those containing (3% dietary fiber) were noticed, with the exception of rice bran blends. However, highly significant differences in the other replacements were found. Highly significant differences were found in color for all replacements except spaghetti made from semolina, and either wheat bran, shorts, okara (3% D.F) or defatted okara (3% or 5% D.F). Meanwhile, the highest flavor scores were noticed for semolina with shorts 3% D.F, okara 3% D.F, defatted okara3% D.F and apple pomace 3%D.F, as well as the control However, such flavor tended to decrease as the source of dietary fiber increased up tc 3% D. F.

Concerning the tenderness of cooked spaghetti, results showed that addition of okara (at 3%D.F.), shorts, rice bran and apple pomace separately to semolina had no effect on the cooked spaghetti.

Meanwhile, increasing the level of replacement of dietary fiber

Table (5): Protein digestibility and total calories for different blends of spaghetti.

Samples	Protein digestibility(%)		Total calories (kCal/100gm)
	Before cooking	After cooking	
Semolina	81.9	83.4	134.26
Semolina +wheat bran (5% D.F)*	86.6	91.2	120.53
Semolina + shorts(7% D.F)	89.4	95.9	111.65
Semolina + rice bran(5% D.F)	86.7	89.9	125.96
Semolina + defatted rice bran(5% D.F)	89.4	92.0	120.53
Semolina + okara(7% D.F)	78.0	82.3	113.89
Semolina + defatted okara(5% D.F)	76.1	79.9	113.23
Semolina + apple pomace(7% D.F)	92.1	95.1	111.76

* D.F.: dietary fiber.

Table (6): Mean values of the organoleptic properties of cooked spaghetti.

Spaghetti blend	D.F.*	Appearance	Color	Flavor	Tenderness	Stickiness	Total score
Semolina		3.6^{a}	3.6^{a}	4.3^{a}	2.7^{ab}	2.7^{a}	17.6^{a}
Semolina + wheat bran	3%	3.4^{ab}	3.1^{abc}	2.9^{d-e}	3.2^{c-g}	2.4^{bcd}	15.0^{cde}
	5%	2.5^{df}	2.7^{c-f}	2.8^{b-f}	3.2^{c-g}	2.2^{c-f}	13.4^{eig}
	7%	2.0^{eig}	1.9^{hi}	2.0^{i-l}	2.8^{b-f}	1.9^{e-h}	10.6^{j}
Semolina + shorts	3%	3.3^{abc}	3.1^{abc}	3.3^{ab}	3.4^{b-e}	2.4^{bcd}	15.5^{bcd}
	5%	2.9^{bcd}	2.9^{cde}	2.6^{a-e}	3.1^{d-h}	2.2^{c-f}	13.7^{eig}
	7%	2.4^{def}	2.8^{c-f}	2.6^{a-e}	3.0^{e-h}	2.1^{d-g}	13.2^{eig}
	10%	2.1^{eig}	1.9^{hi}	2.1^{h-l}	2.7^{g-j}	1.8^{f-l}	10.6^{y}
Semolina +rice bran	3%	2.5^{df}	$2.2i^{gh}$	2.3^{f-k}	3.3^{b-f}	2.2^{c-f}	12.5^{g}
	5%	2.1^{eig}	1.9^{hi}	2.2^{g-k}	2.8^{f-l}	1.6^{hi}	10.6^{hy}
	7%	1.7^{g}	1.4^{i}	1.7^{kl}	2.2^{j}	1.6^{hi}	8.6^{k}
Semolina + D**. rice bran	3%	2.5^{df}	2.4^{d-h}	2.4^{e-j}	3.0^{e-h}	1.9^{e-h}	12.2^{ghi}
	5%	2.0^{eig}	2.1^{gh}	2.0^{i-l}	2.6^{hij}	1.8^{f-i}	10.5^{y}
	7%	1.6^{g}	1.4^{i}	1.6^{l}	2.3^{ij}	1.7^{ghi}	8.6^{k}
Semolina + okara	3%	2.4^{ab}	3.6^{a}	3.3^{ab}	3.8^{b}	2.9^{a}	17.0^{ab}
	5%	2.8^{cd}	2.8^{c-f}	2.7^{c-g}	3.6^{abc}	2.6^{abc}	14.5^{def}
	7%	2.4^{def}	2.8^{c-f}	2.7^{c-g}	3.1^{d-h}	1.9^{e-h}	12.9^{ig}
	10%	1.8^{g}	2.0^{h}	1.9^{jki}	2.6^{hy}	1.6^{hi}	9.9^{jk}
Semolina + D. okara	3%	3.3^{abc}	3.5^{ab}	3.1^{a-d}	3.7^{be}	2.7^{ab}	16.3^{abc}
	5%	2.5^{de}	3.0^{bcd}	2.4^{e-j}	3.2^{c-g}	2.2^{c-f}	13.3^{big}
	7%	1.9^{ig}	2.2^{igh}	1.7^{kl}	2.6^{hy}	1.6^{hi}	10.0^{jk}
Semolina + apple pomace	3%	3.2^{abc}	2.9^{cde}	3.2^{abc}	3.4^{b-e}	2.3^{b-e}	15.0^{cde}
	5%	2.9^{bcd}	2.6^{c-g}	2.8^{b-f}	3.1^{d-h}	2.1^{d-g}	13.5^{eig}
	7%	2.5^{de}	2.3^{e-h}	2.5^{e-l}	3.2^{c-g}	1.8^{f-i}	12.30^{gh}
	10%	2.0^{eig}	1.8^{hi}	1.9^{jkl}	2.4^{ij}	1.4^{i}	9.5^{jk}

* D.F: dietary fiber. **D: defatted

sources (7 to 10% D.F.) decreased the tenderness of the product. Results also revealed significant differences in stickiness scores of cooked spaghetti processed from semolina and all percentage of replacement of dietary fiber except those made from semolina with okara (3 and 5% D.F.) and defatted okara (3% D.F.) These results contradicted with Kordonowy and Young (1985) who reported that flavor, texture and color of the no-bran spaghetti was significantly rated higher than all other samples. The spaghetti with 10% bran was the second best.

From the above results it could be concluded that the addition of rich sources of dietary fibers *i.e.*wheat bran, shorts, rice bran, defatted rice bran, okara, defatted okara and apple pomace had a great effect on chemical and nutritional characteristics of produced spaghetti.It could also be concluded that the addition of shorts (7%D.F.)to semolina showed a good quality characteristics for increased weight and volume, lowest cooking loss (T.S.S.), high nutritional values (protein digestibility and total calories) and organoleptic properties followed by blends of semolina with either wheat bran or defatted okara (at 5% dietary fiber replacement).On the other hand, semolina with either rice bran or defatted rice bran showed the lowest quality characteristics at any percentage of replacement.

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تأثير إضافة بعض المخلفات الغنية فى الألياف الغذائية على خصائص الجودة و القيمة الغذائية للاسباجتى

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تم فى هذا البحث استخدام بعض المخلفات الغنية فى الألياف الغذائية مثل ردة القمح والسن وردة الارز ورردة الارز منزوعة الدهن والاوكارا والاوكارا منزوعة الدهن والمتبقي بعد عصر التفاح و اضافتها للسيموليا وتم تقييم المخلفات من حيث التركيب الكيماوى وخصائص الجودة والقيمة الغذائية والخصائص الحسية –أظهرت النتائج ان كل الإضافات من مخلفات الحبوب أدت الى الزيادة فى الوزن والحجم فى الاسباجتى المنتجة مقارنة بالكنترول .كما وجد ان المخلفات الغنية بالألياف تظهر أعلى فقد فى المواد الصلبة الذائبة فى ماء الطبخ مقارنة بالكنترول – بالإضافة الى ان هذه المخلفات حتى ٣% ألياف غذائية لا تسبب أى تأثير على قوة القطع للاسباجتى المطبوخة فى حين ٥ الى ١٠% الياف غذائية قللت من قوة قطع الاسباجتى المطبوخة. كما أظهرت النتائج تاثير إضافة مثل هذه المخلفات على محتوى الكربوهيدرات والبروتين للاسباجتى المنتجة. بالإضافة إلى أن مختلف مصادر مخلفات الألياف الغذائية تقلل السعرات الكلية للاسباجتى المطبوخة المصنعة .كما وجد أن إضافة السن حتى (٧% الياف غذائية) للسيموليا أظهرت خصائص جودة فى زيادة الوزن والحجم وأقل مواد مفقودة فى ماء السلق وأيضاً صفات غذائية أعلى من حيث كفاءة البروتين المهضوم وخفض عدد السعرات وأيضا فى الخصائص الحسية يليها السيموليا المصنوعة من اضافة ردة القمح أو الاوكارا منزوعة الدهن (عند ٥% ألياف غذائية) .

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