Utilization of Date Seed Powder to Produce Some Food Commodities With High Fiber Content

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Abstract: In this study, the effect of incorporating date seed powders in different ratios with rice grits and semolina flour to produce high fiber extrudates and macaroni was evaluated. The results indicated that adding date seed powders to rice grits caused a reduction in the expansion ratio, bulk density and breaking strength of the resultant extrudates. Adding date seed powders to semolina caused a decrease in breaking strength of the processed macaroni and an increase in the absorbed water and the solid substance lost to cooking water. Sensory evaluation revealed that rice extrudates and macaroni with very good grade could be obtained by incorporating date seed powders up to 8% and 12% to rice grits and semolina flour, respectively.

Keywords: Date seed powder, food commodities, fiber content.

INTRODUCTION

The use of whole date seeds as an animal feed which a part from the value of the protein and fat is favored by the rather high hemicelluloses content. However, feed value is not only determined by composition but also by accessibility and digestibility of the components. The hard, enclosed structure of the seed is a real obstacle to optimize the feed value, although it is also clamed that pits are an excellent slow release energy feed for camels during long desert journeys (Barreveld, *et al.*, 1993).

Some attention has been given to investigate microbial conversion of date seeds such as utilization of date pits and cheese whey for the production of citric acid by *Candida lipolylica* Abou-Zeid, 1983. As well as production of protein from date pits by *Aspergillus oryzea* and *candida utilizes* (Ogaidi, 1985 & Ogaidi, 1988).

Almana and Mahmoud, 1994 used date seeds as an alternative source of dietary fiber in Saudi bread, palm date seeds were milled into two fractions: fine and course. Total dietary fiber (TDF) content was found to be around 71 and 80% respectively. Breads containing milled date seed fractions were slightly lower in protein and slightly higher in fat but substantially higher in total and soluble dietary fiber than the control bread. Coarse fraction at 10% replacement level was found to increase the TDF contents in bread by four fold without significant adverse effect on bread quality. Furthermore bread containing 10% milled coarse fraction was better or similar to corresponding wheat bran control in sensory evaluation.

In this study, the effect of incorporating date seeds powder in different ratios with rice grits and semolina flour to produce high fiber extrudates and macaroni was evaluated.

MATERIAL AND METHODS

1. Materials

Date Seeds: Seeds of two Egyptian date varieties (*Phoenix dactylifera L.*) namely Shamia (dry variety), Hayani (fresh variety), and a mixture of different seeds were obtained from the date fruits that used in the project number 212 titled in "Creation of New Technologies in date processing to produce salable date products and utilizing date wastes. Sponsored by the Academy of Science and Technology" El-Samahy and Co-Workers (1998- 2001).

The seeds were washed in water several times to remove any adhering date flesh and then air dried at room temperature. The dried seeds of each variety were ground separately using a Mill (Condux-werk Wolfgang by hanak. Type cs 15/10/01 N0336160) to fine particles. The resulted fine ground date seed powders were analyzed (Table1) and stored under refrigeration until processing.

2. Methods of processing

2.1. High fiber products:

Extrudates: Rice grits was substituted by fiber containing ingredients at different levels to prepare the high fiber mixtures. Fiber containing ingredients were Shamia, Hayani and mixed date seed powders as well. The substitution levels were 2, 4, 6 and 8% in case of Hayani and mixed date seeds powder, while it were 2, 4, 6, 8, 10 and 12% in the case of Shamia date seeds powder. The ingredients were thoroughly mixed by using a mechanical mixer in 1Kg batches. Water was added (in spray form) to adjust the moisture content of blends to 16%, mixed well again and stored in polyethylene bags in refrigeration condition for 24 hr. before extrusion to allow the moisture to equilibrate.

A Brabender laboratory single-screw extruder (20 DN). Mod. No. 186501 type 832500 equipped with feeding device AEV 300, Nr.141923, type GNF 101412; Do-corder (EDGE 330) to control the feeding device speed and temperature regulators for two extruder zones and die head; compressed-air cooled collars controlled by thermostat; straight shaft screw with 5:1 comparison Mod. Nr. 643270, and ribbon die with a 20X 0.8 mm with temperature control channels No. 673295 was used. This model of extruder had a 20 mm diameter spiral grooved barrel with a length to

diameter ratio (L/D) of 20:1. Some experiments were done on the extruder to define the best conditions appropriated to produce high fiber products. These conditions were: the screw speed was set at 200 rpm. The raw mix was fed at a rate of 130 rpm. The feeding, cooking and die zone temperatures were reached to the desired temperature, and the ingredients were discharged into extruder hopper. The feed screw speed was increased slowly up to desired set feed rate. When the extruder reaches to the steady state, torque and dough temperature were read directly from the digital indicators from each trial. The resultant extrudates were directly dried in an air oven drier at 110°C for 5 min. and allowed to reach room temperature. Immediately after processing, the samples of extrudates were collected in polyethylene bags, sealed and stored at room temperature (25°C) until physical, chemical and sensory analyses.

Macaroni: The macaroni samples were prepared; using pasta matic 1400 machine, Italy, from semolina flour containing 0, 3, 6, 9 and 12% of Hayani or Shamia and/ or mixed different varieties of date seed powders. The macaroni flour blends were mixed with enough water so that the dough moisture content reached 36% for blends of (0, 3, 6, 9%) and 38% for blend of (12%). The macaroni dough strips at the desirable length were dried at 60 °C. The width and thickness of dried macaroni stripes were 0.6 and 0.2 cm, respectively.

Table (1) Chemical composition of date seeds varieties (on dry weight).

Component %	Hayani (fresh)	Shamia (dry)	Mixture from different seeds
Moisture	7.13	4.54	3.07
Ether extract	6.38	5.52	4.90
Protein	6.35	6.90	6.35
Tannins	0.097	0.143	0.122
Pectin	0.021	0.054	0.14
Ash	0.92	0.86	1.02
Crude fiber	9.86	9.25	16.46
Dietary fiber	63.6	63.85	65.42
Lignin	11.66	11.81	12.12
Cellulose	37.72	37.87	38.85
Hemicellulose	13.92	14.17	14.45

Semolina Flour and *Rice grits:* were brought from Cairo Company for milling and bakery Cairo, Egypt

2.2 Functional properties of the processed products:

Functional properties of high fiber extrudates: Particle size distribution for ground materials was determined according to Henderson and Perry, 1955. The specific volume of extrudates was determined by using rape seed displacement as described by Hsieb *et al.*, 1991. Expansion ratio (ER) of extrudates was calculated by dividing the average cross-sectional area of the extrudates by dividing the cross-sectional area of the die-nozzle orifice, according to Chinnaswamy and Hanna, 1988a,b. Each value was the average of 10 readings. Breaking Strength (BS) was determined according to the method described by Bourne, 2002 using Brabender Struct-O-Graph Model No. 8603 OHG Duisburg. The sample was resisted on two parallel support bars that attached to an elevator plate form that is raised at constant speed to contact a sensor bar mounted above the sample and equidistant between and parallel to the lower knife-edges. A strip chart record gives a force-time plot. The equipment was fitted with a 500-cmg spring and plexi glass beam. The beam travel speed was 9 mm/minute. The peak heights of the resultant recorded curves (as Brabender units) for each sample were taken as a texture measure (Breaking force index). To test an extruded strip sample, 10 measurements were taken for each sample. Water absorption (WAI) and Water solubility index (WSI) were tested as described by Anderson *et al.*,1969. The color was determined by Munsell of color (Anon, 1976), which used as a reference for Munsell value.

High Fiber Macaroni: The volume of uncooked and cooked macaroni, increase in volume, water absorbed (weight after cooking) and solid substance loss at two cooking times (12 and 18 min) were evaluated as described by Hummel, 1966. Also, the cooking quality grade was determined depending on the average of solid substance loss percent at two periods of cooking according to the same author. Less than 6 score grade was considered as very good; 6-7 good; up to 9 averages and more was bad.

2.3 Sensory Evaluations:

Extrudates: The sensory evaluation of the extrudates was carried out after processing. Seven properties constitute the overall acceptability; taste (20), crispness (20), odor (15), chewiness (15), color (10), surface characteristics (10) and pore distribution (10) were judged by ten staff members of food Technology Department. The overall acceptability of the samples was calculated from the total score of tested attributes (out of 100). The grades were given according to the following scale; excellent (86-100), very good (85-76), good (66-75), fair (65-51) and poor < 50 as described by Abu-Foul, 1990.

Macaroni: Sensory evaluation such as appearance, color, flavor, texture acceptability, stickiness, bulkiness and firmness of cooked macaroni were overall evaluated organoleptically as described by Larmond, 1970.

Where, macaroni samples were cooked to optimum cooking time in water, drained and served warm to sensory panelists (10 persons).

2.4. Statistical Analyses:

The analysis of variance (ANOVA) was carried out to test the possibility of significance treatments effect. LSD as described by Ott, 1984 was used to perform all possible pair comparisons (between means of different treatments).

RESULTS AND DISCUSSION

Extrudates:

1. Effect of date seed powders on extruder performance and functional properties of rice extrudates

Expansion Ratio (ER): It is clear that the expansion ratios (ER) of the extrudates containing date seed powders were lower than the control sample. This reduction was increased with increasing the date seed powders ratio in all treatments under study (Table 2).

Bulk Density (BD): Bulk density is one of the most important physical properties of the same trend of ER values. The data presented in Table (2) indicated that the (BD) of produced rice grits extrudates was decreased by increasing addition ratios of date seed powders in all samples. The highest effect occurred by using Shamia seed powders followed by Hayani and mixed date seed powders. These results agreed with the results obtained by Yaseen, *et al.*, 2001. Meanwhile, El-Saies, 1998 found that the BD of produced corn strip extrudates was increased by increasing addition ratio of some fiber sources and this increase might be due to its violent effect on starch gelatinization and on the cell wall also.

Water Absorption Index (WAI): As shown in Table (2) it was noticed that the WAI was increased by adding Shamia, Hayani and mixed date seeds powders. The increment in WAI was slightly increased by increasing the levels of date seeds powder in the blends. These results may be due to the higher ability of fiber to absorb water than cooked-starch granules in extrudates Abd El-Hady, 1998.

Water Solubility Index (WSI): The WSI of the extrudates was increased by increasing the ratio of adding date seed powders to rice grits blends compared with the control sample as shown in Table (2). Therefore, the effect of increasing WSI may depend on the addition level of date seed powders. This increment was pronounced by increasing date seed powders ratio. The increment in WAI may be contributed to the greated shear degradation of starch during extrusion at high temperature. In addition, this increase in WAI may be due to change of portion from insoluble dietary fiber to soluble form because of the extensive conditions used. This explanation agreed with that mentioned by Aoe *et al.*, 1989 and Berglund *et al.*, 1994.

Breaking Strength (BS): The results presented in Table (2) showed that the BS values of the product samples varied depending upon type and ratio of fiber in blends. The extruded blends contained rice grits with date seed powders gave a decrease in BS values comparable with control sample. It is clear that the BS values were decreased with increasing the fiber in blends. The reduction in BS is probably happened due to increased cell number per pixel area while average cell size decreased. In addition to the above explanation, the increasing of fiber size tends to rupture the cell walls causing more weak points in matrix extrudate structures. This means that, extrudates required a smaller load to shear through the extruder as fiber content increased. This result probably because of higher fiber percentage, which can cause uncojunction between the product matrix resulting in lowering BS, these results agreed with that reported by Moore *et al.*, 1990.

Color of Extrudates: Color is important to attract consumers before they consume a product. The results showed that the color of extrudates containing date seed powders were darker (lower "L" values) than the color of that produced from rice grits only, Table (2).

Adding date seed powders reduced color or brightness "L" values. Samples with higher date seed powder concentrations were generally 11- 15 units lower than that of rice grits sample. This reduction in lightness value was more pronounced in extrudates containing Shamia date seed powders and/or mixed date seed powders.

Comparing between "a" values (degree of redness) of extrudates, indicated that extrudates prepared by using Shamia and Hayani seed powders within the tested levels were clearly more red than extrudate prepared by using rice grits only. A slightly increase in "a" values was noticed in extrudates of mixed date seed powders compared with control sample. The higher "a" values of extrudates may be attributed to the presence of phenolic compounds naturally existing in date seeds. So, the colors of extrudates were influenced by the initial chemical structure of the date seed powders added and extrusion process.

Extrudates tended to have higher "b" values indicating higher degree of yellowness than those of rice grits extrudates. The increasing in yellowness with increasing date seed powders might have been caused by the phenolic compounds present in the date seeds.

2. Effect of adding date seed powders to rice grits on the chemical composition of the resultant extrudates

The data showed that, increasing the addition rate of date seed powders in blends before extrusion increased the dietary fibers content, Table (3). With regard to the components of extrudate samples, variations were depended upon the chemical composition of date seed powders and substitution levels. Oil content percentages in Shamia, Hayani and mixed date seeds powders were higher than that of rice. Therefore, the oil content was increased in the resultant extrudates with increasing its addition ratio. Finally, total hydrolysable carbohydrate was calculated by difference and it was obviously decreased in the extrudates by increasing date seed powders ratios in the blends.

3. Effect of adding date seed powders to rice grits on sensory properties of resultant extrudates

The sensory evaluation used in this study provided a basis for determining the sensory characteristics

important for accepting and aid in identifying the effect of adding fiber ingredients at constant conditions.

Regarding the characters of taste and odor, there were no significant differences between the scores given for the control sample and other samples except the extrudate sample that contained 8 % Shamia date seed powders and that contained 4% mixture of date seed powders in case of taste and odor respectively, Table (4).

The data showed that no significant difference in crispness scores between the control sample and those blends which containing up to 6 % of date seed powders. After that, by increasing date seed powders content in blends, the crispness mean scores of extrudates were decreased significantly (but not linear or gradually) as compared to the control sample. These results indicated the relationship between the presence of fiber and the structure of extrudates. In this respect, Skierkowski *et al.*, 1990 mentioned that crispness scores were high for extrudates with up to 21.5 % fiber. Many authors reported that attempts to incorporate high level of fiber in extruded product often resulted in compact non-crisp, tough and undesirable texture in extrudates (Anderson, *et al.*, 1981 & Hul., 1994).

Data indicated also that there were no significant differences in showiness mean scores between the control and those blends containing 10 and 12 % Shamia seeds powder. After that by increasing date seed powders content in blends, the showiness mean scores of extrudates were decreased significantly as compared to the control sample. In general increasing fiber contents in extrudate blends at high temperature led to slightly decrease in showiness of the product. There were some significant improvement in color mean scores of extrudates especially at the higher date seed powders addition levels.

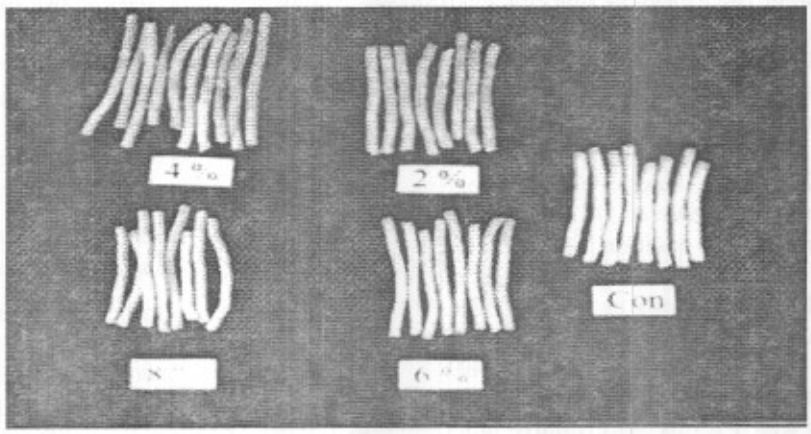
The reduction observed in surface characteristics of the extrudates may be explained by the presence of fiber, which led to a rough surface texture of extrudates and causing a slightly regular, ridged surface distortion "Sharkskin" on extrudates surface.

Statistical analysis of the data, showed that there was significant difference in the mean scores of pore distribution between the control and those blends which containing up to 12 % Shamia seed powders (except 8 %), 6 and 8 % Hayani and mixed date seeds powder. After that by increasing date seeds powder in blends, the pore distribution mean scores of extrudates was decreased significantly as compared to the control sample. This reduction in pores is attributed to the presence of fiber materials, which lower the expansion of extrudates. Many researchers mentioned that increasing fiber in blends caused the extrudates to have more open structure, larger cells and decrease the average cell size (Anderson, *et al.*, 1981, Lue, *et al.*, 1991 & Hul., 1994).

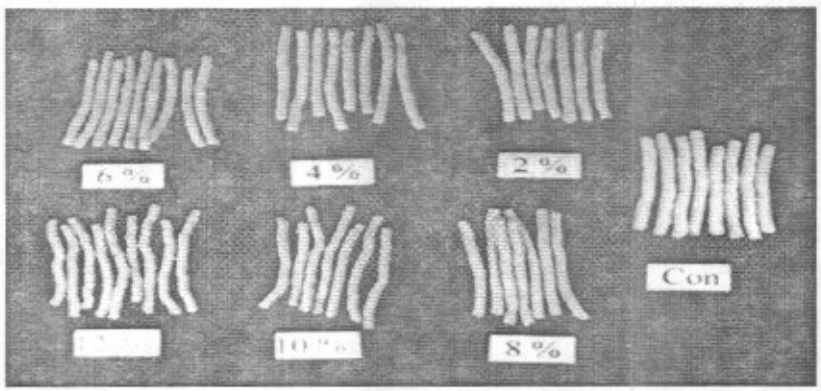
Table (2): Effect of date seed powder sources on extruder performance and functional properties of rice extrudates.

Base formula and substitution	Extruder performance		ER	BD g/100 cm^3	WAI* g/g	WSI (%)	BS (B.U)	Colour*		
	Torque (Nn)	Temp. °C						L	a	b
Control, rice grits	16.5	165	0.320	61.17	8.47	26.53	499	83.9	12.7	4.3
Shamia seeds powder										
2%	15.95	165	0.287	55.52	8.48	27.26	483	76.8	13.7	8.2
4%	15.85	167	0.286	55.08	8.55	28.60	478	74.7	13.7	9.0
6%	15.75	169	0.285	54.65	8.66	29.91	470	72.4	13.9	9.9
8%	15.50	170	0.266	52.91	8.73	29.85	469	72.1	14.4	10.4
10%	14.65	168	0.254	51.96	8.91	30.33	210	69.5	14.5	10.9
12%	14.50	168	0.243	50.10	8.99	31.21	202	69.0	14.5	10.6
Hayani seeds powder										
2%	16.15	170	0.299	56.91	8.49	24.61	490	78.4	13.1	7.5
4%	15.85	170	0.283	57.62	8.54	25.45	472	78.0	11.9	7.9
6%	15.71	168	0.267	51.63	8.61	25.69	463	75.6	12.8	7.8
8%	15.35	168	0.248	53.41	8.79	26.68	465	72.5	13.1	9.3
Mixture from different seeds										
2%	16.11	168	0.277	59.10	8.52	24.47	469	79.5	12.7	7.0
4%	15.90	168	0.274	56.78	8.57	25.61	450	77.2	12.7	7.9
6%	15.50	168	0.263	55.04	8.66	26.01	444	72.9	12.8	8.5
8%	15.45	168	0.261	54.25	8.80	26.37	453	71.3	12.8	8.6

* Colour L = degree of lightness a = degree of redne b = degree of yellowness



(A)



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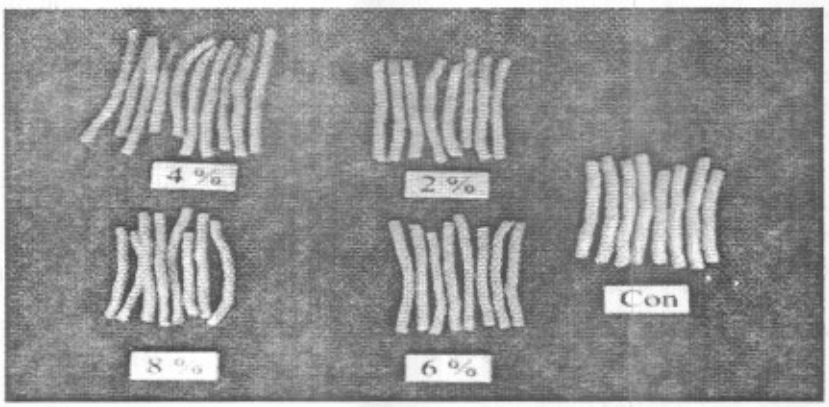

(C)

Fig. (1): Extrudates of rice grits mixed with different ratios of: A) Shamia date seed powders, B) Haiani date seeds powder. and C) Mixture from different seed powders.

Finally, the overall acceptability scores were decreased significantly by increasing fiber contents in final products because the fiber materials could affect the most extrudates characteristics. Always, consumers are satisfied and agreeable on these groups of high fiber products in spite of the defect in their sensory characteristic because of its medical effects.

According to previous results, the sensory evaluation indicated that rice extrudates with very good grade could be obtained by adding Shamia date seeds powder up to 12 % and by adding Hayani and mixture from different seeds powder up to 8 %.

Macaroni

1. Effect of incorporating date seeds flour with semolina on breaking strength and color of the produced macaroni

Breaking strength (BS): In general, adding date seed powders to semolina flour caused a decrease in the BS. Values of the resultant macaroni comparable with control sample (Table 5). This reduction in (BS) was

more pronounced in the macaroni sample that contained 12 % Shamia date seeds powder.

Color of Macaroni: The results showed that the color of macaroni containing date seed flours were darker (lower "L" values) than the color of that produced from semolina flour only. Adding date seed flours, reduced color or brightness "L" values. Increasing date seed flours ratio in macaroni blends lowered "L" values with about 15-18 units, at 12 %, addition level. This reduction in lightness value was more pronounced in mixed date seed powders and Shamia date seed flours. Making a comparison between "a" values (degree of redness) of macaroni samples, indicated that macaroni prepared by using Shamia or mixture and/or Hayani seed flours within the tested levels were clearly more red than those of macaroni prepared using semolina only. Macaroni prepared from semolina was tended to have higher "b" values indicating higher degree of yellowness, than those of blended Shamia or Hayani and/or mixture of date seed flours. These results agreed with the results, which obtained by Abou-Zeid *et al.*, 1990 who reported that the addition of orange, apricot, and date by products as a source of fiber to produce high fiber macaroni.

2. Effect of adding different ratios of date seed flours on macaroni cooked properties.

Raising the addition level of date seeds flour in pasta and prolonging cooking time increased the volume of the cooked macaroni, (Table 6). The same pattern was noticed in both water absorbed (which means weight increasing after cooking) and solid substances lost to water. Both properties were increased, as the level of date seed flours was increased, as well as by prolonging of the cooking time. Generally, it was observed that the increase in water absorbed appeared to correlate with that in volume.

From the same data in Table (6), it was noticed that, the cooking quality grades for macaroni of control sample and that containing 3 % Hayani date seed flours were scored a high grade (very good). Meanwhile, macaroni samples contained 3, 6 and 9 % mixture from different seed flours were recorded good grade. The other samples had average cooking quality grades.

3. Effect of adding date seed powders to semolina flour on sensory properties of the resulted cooked macaroni.

There were significant decreases in color scores of cooked macaroni when the level of date seed powders was raised in macaroni (Table7). The change in color may be due to the phenolic compounds, which present in date seed flours.

Data indicated that there were no significant differences in flavor mean scores in cooked macaroni between the control sample and those blends which containing up 12 % of Shamia date seeds flour and up to 9 % of Hayani and/or mixture date seed flours.

The data presented in Table (7) showed that there were no significant differences in stickness and bulkiness among macaroni control sample and those blends which containing up to 12 % of Shamia or Hayani and/or mixture of date seed flours.

Regarding the firmness of the cooked macaroni, there were more or less significant differences between the scores of samples (Table 7).

Finally, the overall acceptability scores were decreased by increasing date seed powders contents in final products because the fiber materials could strongly affect the most macaroni characteristics. According to previous results, macaroni with very good grade could be obtained by adding date seed flours to semolina flour up to 12 %.

Table (3): Effect of addition of date seed powders (as a fiber source) on the chemical composition of rice grits extrudates.

Base formula and substitution %	Crude fiber %	Dietary fiber %		Total protein %	Ether extract %	Ash content %	Total carbohydrate %
		Before extrusion	After extrution				
Control (rice grits)	0.65	0.64	0.79	8.90	2.51	1.12	86.03
shamia seed							
2%	0.94	1.71	2.01	8.21	2.60	1.34	86.25
4%	0. 48	3.01	3.85	7.99	2.92	1.06	82.70
6%	1.89	3.85	4.30	7.51	3.02	1.14	82.14
8%	2.15	5.13	5.75	7.10	3.14	1.23	80.62
10%	2.58	7.00	7.28	6.86	3.36	1.14	78.79
12%	3.21	8.24	9.91	6.14	3.81	1.55	75.38
Hayani seed							
2%	0.85	2.19	2.53	8.42	2.78	1.20	84.23
4%	1.26	3.82	4.06	7.91	2.50	1.51	82.76
6%	1.64	4.35	4.88	6.93	3.86	1.35	81.34
8%	2.18	6.11	6.59	6.23	4.00	0.83	80.17
Mixture from different powders							
2%	0.98	2.15	2.72	8.78	2.59	1.17	83.76
4%	1.61	3.75	3.94	8.25	2.69	1.06	82.45
6%	1.96	4.29	4.53	7.54	2.99	0.93	82.05
8%	2.30	5.37	5.81	7.00	3.51	0.97	80.41

Table (4): Effect of adding date seed powders to rice grits on sensory properties of rice-based extrudates

Base formula	Taste (20)	Odour (15)	Crispness (20)	Chewiness (15)	Color (10)	Surface characteristics (10)	Pore distribution (10)	Over all acceptability (100)	*Grad*
Control (rice grits)	16.5^{a}	13.6^{a}	18.4^{a}	13^{a}	7.5^{a}	8.7^{a}	8.3^{a}	86	Exc.
Shamia seeds									
2 %	16.7^{a}	14.1^{a}	17.8^{a}	12.4^{ab}	8.2^{a}	8.6^{a}	8.5^{a}	86.3	Exc.
4%	15.9^{ab}	13.4^{a}	17.3^{ab}	12.1^{ab}	7.9^{a}	8.4^{a}	8.3^{a}	83.3	V.G.
6%	15.7^{ab}	13.4^{a}	16.8^{b}	12^{ab}	7.3^{b}	7.8^{ab}	7.6^{ab}	80.6	V.G.
8%	14.7^{b}	12.9^{a}	15.9^{b}	11.8^{b}	6.9^{b}	7.1^{b}	6.6^{b}	75.9	V.G.
10%	16.6^{a}	13.2^{a}	17.4^{ab}	13.0^{a}	8.5^{a}	8.6^{a}	8.3^{a}	85.6	V.G.
12%	16.2^{a}	13.2^{a}	16.6^{b}	12.7^{a}	7.9^{a}	8.1^{a}	7.5^{b}	82.3	V.G.
L.S.D.	1.5371	1.2286	1.3135	1.0801	1.0055	0.9706	0.9844	1.156	
Hayani seeds									
2%	14.8^{a}	12.9^{a}	15.4^{bc}	11.6^{b}	7.3^{ab}	7.7^{b}	7.2^{b}	76.9	V.G
4%	14.6^{a}	12.6^{a}	14.8^{c}	11.3^{b}	6.9^{b}	6.5^{c}	6.2^{b}	72.9	V.G
6%	16.5^{a}	13.4^{a}	17.8^{ab}	12.4^{ab}	8.0^{a}	8.4^{ab}	8.0^{ab}	84.5	V.G
8%	16.3^{a}	13.0^{a}	16.7^{ab}	12.2^{ab}	7.6^{ab}	7.5^{b}	7.3^{a}	80.6	V.G
L.S.D.	2.0524	1.4579	1.7641	1.2405	1.0105	0.9286	1.0187	1.353	
Mixture from different seeds powder									
2%	15.6^{a}	12.9^{ab}	16.0^{b}	11.4^{b}	7.4^{b}	6.5^{b}	7.0^{b}	76.8	V.G
4%	15.1^{a}	12.2^{b}	12.9^{c}	11.0^{b}	7.6^{ab}	6.0^{b}	6.4^{b}	71.2	G.
6%	16.5^{a}	13.5^{a}	17.7^{a}	12.8^{a}	8.5^{a}	8.6^{a}	8.5^{a}	86.1	Exc.
8%	16.2^{a}	13.4^{ab}	16.9^{ab}	12.6^{a}	8^{ab}	8.1^{a}	8.2^{a}	83.4	V.G
L.S.D.	1.7124	1.2728	1.6677	1.0349	1.0100	1.0745	1.0252	1.257	

Means with the same attribute have same letters are not significantly different ($P \geq 0.05$)

Table (5): Effect of date seed powders and semolina flour blends on breaking strength and color of the produced macaroni.

Added seeds flour	Breaking strength (BU)	Color*		
		L	a	B
Semolina flour	474	78.3	4.9	17.0
Shamia seeds flour				
3%	429.0	71.2	8.6	14.5
6%	438.3	67.3	9.4	13.8
9%	357.5	64.5	9.9	13.1
12%	205.0	62.3	9.7	12.5
Hayani seeds flour				
3%	464.0	71.6	7.8	14.5
6%	449.0	65.1	9.2	13.9
9%	390.0	65.8	9.1	13.1
12%	385.0	62.6	9.2	12.7
Mixture from different seeds flour				
3%	450.0	70.5	7.8	13.9
6%	439.0	63.6	8.5	12.7
9%	406.3	61.7	8.9	12.5
12%	410.0	59.9	9.5	12.5

* L: degree of lightness. a: degree of redness. b: degree of yellowness

Table (6): Effect of adding different ratios of milled date seeds varieties on macaroni cooking properties

Added seeds flour	Volume of macaroni products in cm^3	Cooking time min	Water absorbed in gm.	Volume cooked macaroni products in cm^3	Increase in volume *	Solid substance lost to water in %	Cooking quality Grades
Control	**9**	12	19	26	2.9	4.8	Very good
		18	24	31	3.4	5.1	
Shamia date seeds flour:							
3%	**9**	12	20	28	3.1	5.4	Good
		18	24	35	3.9	7.2	
6%	**9**	12	21	31	3.4	6.0	Good
		18	24.9	36	4	7.5	
9%	**10**	12	21.5	31	3.1	6.5	Good
		18	25.3	38	3.8	7.2	
12%	**10**	12	22	31	3.1	7.1	Average
		18	26	38	3.8	8.3	
Hayani date seeds flour:							
3%	**10**	12	19.3	30	3.0	5.0	Very good
		18	25	39	3.9	5.8	
6%	**10**	12	20	31	3.1	6.2	Average
		18	26	39	3.9	8.9	
9%	**10**	12	20.8	31	3.1	6.4	Average
		18	27	40	4.0	9.0	
12%	**10**	12	22	35	3.5	6.8	Average
		18	27	41	4.1	9.2	
Mixture from different seeds flour:							
3%	**9**	12	19.6	27	3	5.7	Good
		18	24.2	32	3.6	7.0	
6%	**9**	12	20	30	3.3	5.5	Good
		18	25	33	3.7	7.2	
9%	**9**	12	20.3	31	3.4	5.8	Good
		18	26	34	3.8	8.1	
12%	**9**	12	21	33	3.7	6.3	Average
		18	27	39	4.3	9.0	

Increase in volume is defined as the ratio of volume of cooked macaroni divided by volume of macaroni before cooking.

Table (7) Effect of adding date seeds flour to semolina on the sensory properties of the resulted cooked macaroni.

Added date seeds flour	Appearance (10)	Colour (10)	Flavor (10)	Stikness (10)	Bulkiness (10)	Firmeness (10)	Over all acceptably	Grad
Control	**9.4^{a}**	**9.5^{a}**	**9.6^{a}**	**7.1^{c}**	**6.9^{c}**	**8.9^{a}**	**85.84**	**Ex.**
Shamia date seeds flour:								
3%	9.1^{a}	8.7^{a}	9.5^{a}	8.0^{b}	7.6^{c}	8.7^{a}	86.17	Ex
6%	8.9^{a}	6.5^{b}	9.6^{a}	8.2^{b}	8.7^{b}	8.6^{a}	84.34	V.G.
9%	8.3^{b}	6.4^{b}	9.4^{a}	8.6^{ab}	9.6^{a}	8.4^{ab}	84.67	V.G.
12%	8.0^{b}	4.1^{c}	9.3^{a}	8.8^{a}	9.6^{a}	7.9^{b}	79.66	G.
L.S.D.	0.58	0.98	0.36	0.45	0.598	0.58	0.59	
Hayani date seeds flour:								
3%	9.3^{a}	8.3^{b}	9.5^{ab}	7.8^{b}	7.6^{b}	7.5^{b}	83.50	V.G.
6%	9.0^{a}	7.4^{c}	9.4^{ab}	8.0^{ab}	8.6^{a}	7.4^{b}	83.17	V.G.
9%	8.0^{b}	7.0^{c}	9.3^{ab}	8.1^{ab}	8.8^{a}	7.9^{b}	82.00	V.G.
12%	8.2^{b}	6.1^{a}	9.0^{b}	8.4^{a}	9.2^{a}	7.9^{b}	81.50	V.G.
L.S.D.	0.615	0.759	0.57	0.469	0.75	0.679	0.64	
Mixture from different seeds flour:								
3%	9.3^{a}	8.1^{b}	8.9^{ab}	8.0^{b}	7.6^{bc}	7.9^{b}	83.17	V.G.
6%	8.7^{a}	7.5^{b}	9.2^{ab}	8.3^{ab}	8.3^{ab}	7.1^{c}	82.00	V.G.
9%	8.1^{b}	6.6^{c}	9.0^{ab}	8.3^{ab}	8.4^{a}	8.1^{b}	81.00	V.G.
12%	7.5^{b}	6.1^{c}	8.7^{b}	8.7^{a}	8.8^{a}	8.9^{a}	81.33	V.G.
L.S.D.	0.745	0.86	0.78	0.625	0.71	0.66	0.62	

There is no significant difference between mean (within the same property) designated by the same letter at $P \geq 0.05$

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