Improving the nutritive value, physical and sensory properties of wheat biscuits fortified with semolina.

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Abstract: Semolina is considered as a valuable healthful functional food. The present investigation was performed to assess nutritional status of wheat biscuits and semolina fortified biscuits. Study included determination of gross chemical composition, caloric value, minerals (Mn, Ca, Fe, Cu, P, Na and K), vitamins (C, Folic acid, A, and E), and amino acid composition of wheat biscuits and 40%, 50% semolina fortified biscuits. Likewise, physical and sensory characteristics of studied biscuits were assessed. The data revealed that 50% semolina fortified biscuits proved to be nutritious functional healthful food. It improved both physical, sensory characteristics and increased ash, crude fiber, and carbohydrates content, but decreased fat and caloric value. While, it recorded the highest Mn, Na contents as well as increased vitamins C, folic acid, A, and E contents and threonine content resulting in an improvement of the nutritive value of 50% semolina fortified biscuits. Therefore, it could be recommended for caloric reduced diets for diabetic, obese and overweight persons. Besides, it should be used as an ingredient in the bakery industry, i.e. in biscuits, bread snack foods, breakfast foods, and cakes.
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1- Introduction:

Semolina is considered as a valuable nutritional healthful function food. It has high protein, minerals and vitamins, with low fat, no cholesterol and moderate calories (Matveef, 1969; Zaitsev *et al*., 1979; Pomeranz, 1983; Krelowska-Klaus, 1992; Yaseen, 1993; Grover *et al*., 1994; Shujaat *et al*., 1994; Grewal *et al*., 1999 and Samaan *et al*. (2006).

Besides, semolina is a good source of all essential amino acids (Carnovale and Quagila, 1973; Pomeranz, 1983; Bahnassey *et al*., 1986; Gerwat and Hira, 2001 and Abdel-Aal and Hucl, 2002).

Furthermore, semolina slows down digestion rate resulting in satiety feeling and reducing caloric intake. Due to its high potassium content it improves kidney function. Likewise it contains P, Zn and Mg which are very useful for bones and nervous system (Meuser *et al*., 1981; Sazalay and Muranyt, 1982; and Bahnassey *et al*., 1988).

Moreover, semolina improves the efficiency of the immune system due to its high content of vitamins A and E (Cirilli, 1971 and Golovinski, 1979).

Semolina adjusts blood glucose content in diabetic patients since it affects the glycemic response (Foschia *et al*., 2014).

The fortification of bakery products and bakers confectionery with semolina, i.e. bread and toast bread, extracted snack, breakfast cereals and biscuits were reported by several authors, i.e. Grewal and Hira (2001), Abdel-Aal and Hucl (2002), Pasqualone *et al*. (2006), Peressini *et al*. (2006), Samaan *et al*. (2006), Alexa *et al*. (2009), Martinez-Villaluenga *et al*. (2010), Mehrajafatema *et al*. (2011), and Foschia *et al*. (2014).

This investigation was designed to produce fortified wheat biscuits with semolina, which has better nutritional value, available and relatively cheap and does not require any preparation efforts before use. The objectives of this investigation was to study the gross chemical, caloric value, the mineral composition, the vitamin composition, the amino acid composition, as well as physical and sensory quality attributes of wheat biscuits and semolina fortified biscuits.

2. Material and Methods:

2.1. Materials:

Five kg wheat flour 72% extraction hard red winter and 5 kg of semolina obtained from El-Haram Milling Company, Faisal, Giza in January 2015. Sugar powder, powdered milk, butter, sodium chloride, ammonium bicarbonate, sodium bicarbonate and baking powder were purchased from Cairo local market in January 2015.

Both wheat flour and semolina were kept in glass containers at 4°C in the refrigerator till the analysis.

2.2. Technological process:

2.2.1. Biscuit formula and ingredients:

Control biscuit dough was prepared according to the formula presented in Table (1), Rao and Manohar (1999). The supplemented biscuits with semolina were prepared using the same formula except for replacing the wheat flour with 40% and 50% of semolina.

Table (1): Wheat flour biscuits formula*.

Ingredients	Gram
Wheat flour 72% extraction	100
Powdered sugar	20.00
Sodium chloride	0.50
Powdered milk	10.00
Butter	40.00
Ammonium bicarbonate	1.00
Sodium bicarbonate	0.50
Baking powder	0.50
Water	25.00

* Rao and Manohar (1999).

2.2.2. Dough preparation:

Powdered sugar and butter were creamed in Braun Mixer with a flat beater for 2 minutes at 5 rpm. Water containing sodium chloride, ammonium bicarbonate, powdered milk, sodium bicarbonate and baking powder were added to the cream and mixed for 5 minutes at 125 rpm to obtain a homogenous cream. Thereafter the flour was added slowly to the above cream and was mixed for 2 minutes at 60 rpm to obtain biscuit dough (Saba, 1997).

2.2.3. Preparation of biscuits:

The dough was sheeted to thickness of about 3 mm using Atlas Brand Rolling Machine. The sheeted dough was cut into round shape using a 45 mm diameter cutter and baked on an alluminium tray in an electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed in polyethylene bags stored under desiccation (Vatsala and HardiasRao, 1991, and Manohar and Rao, 1997).

2.2.4. Preparation of different blends of biscuits:

Blends of biscuits:

Blends of biscuits were prepared using wheat flour 72% extraction rate as control or those which were substituted with 40% and 50% semolina.

3- Methods:

3.1- Physical evaluation of biscuits:

Biscuit were evaluated for height (cm), width (cm), spread ratio and spread factor. Five biscuits were used for the evaluations from the three studied biscuits and averages were recorded. The spread ratio and spread factor were calculated according to Manohar and Rao (1997) using the following equations:

$$Spread\ ratio = \frac{Width}{Height}$$

$$Spread\ factor = \frac{Spread\ ratio\ of\ sample}{Spread\ ratio\ of\ control}\ x\ 100.$$

3.2. Sensory evaluation of biscuits:

Sensory evaluation for the color, texture, taste, odor, and overall acceptability were done in order to determine consumer acceptability. A numerical hedonic scale ranging from 1 to 10 (1 is very bad and 10 for excellent) was used for sensory evaluation (Larmond, 1977). Ten experienced judges participated in the test.

3.3. Gross chemical composition:

Moisture, protein, fat, crude fiber and ash were determined according to the methods described in A.O.A.C. (2010).Total carbohydrates content was calculated by difference (100 – total gross chemical composition) on dry weight basis according to A.O.A.C. (2010).The caloric value was calculated according to the method of Sleet (2010).

3.4. Mineral composition:

Total content of elements was carried out using a mixture of ($HClO_4$/ HNO_3) according to (Inductive Coupled Plasma Emission Spectrometry). The elements Ca, Mn, Cu and Fe were determined using ICP (ICAP6200) according to Isaac and Johnson (2002). Sodium and potassium contents were estimated using Flame Photometry (Jenway PFP7) according to the procedure reported by A.O.A.C. (2005). Phosphorus was estimated using GRC Atomic Absorption 906A according to the procedure described in A.O.A.C. (2012).

3.5. Vitamins assay:

Vitamin C was determined using Aglient HPLC (uv-vis) as described by Odriozolo-Serrano *et al*. (2007). Folic acid was determined using Surveyour HPLC ((PDA) as described by Albala-Hurtado *et al*. (1997). Vitamins A and E were determined using Schmidzua HPLC (PDA) as described by Gomis *et al*. (2000).

3.6. Amino acids composition:

Acid hydrolysis was carried out according to the method of Baxter (1996). The dried and defatted grinding sample (Ca. 0.2 g) was hydrolyzed with 6N HCl (10 ml) in sealed tube, heated in an oven at 110°C for 24 hours. The resulting solution was completed to 25 ml with de-ionized water. After filtration, 5 ml of hydrolyzate was evaporated until to be free from HCl vapor.

Then the residue was dissolved in diluting citrate buffer (pH 2.2). The system used for the analyses was High Performance Amino Acid Analyzer, Model: Ingos AAA400.

3.7. Tryptophan determination:

Tryptophan was determined by the colormetric method using UV-160IPC, Shimadzu. UV-Visible spectrophotometer (550 µm) according to the method described by Sastry and Tammuru (1995).

4- Results and Discussion:

4.1. Physical characteristic of biscuits:

Semolina had been considered as a functional food supplement in several bakery products. The mean values of physical characteristics of wheat biscuits and

fortified wheat biscuits with 40% and 50% semolina are presented in Table (2) and Figures 1-3.

The data recorded an equal increment (10) of both 40% and 50% semolina fortified biscuits. Considering the spread factor of control biscuits (100% wheat flour 72% extraction ratio biscuits) as 100, results given in Table (2) indicated that it increased to 250for 40% and 50% semolina fortified biscuits. The data agree with Foschia *et al*. (2014) findings.

Table (2):Physical characteristics of 100% wheat flour 72% extraction biscuits (control) and wheat flour biscuits supplemented with 40% and 50% semolina.

Biscuit samples	Width[a] (cm)	Thickness[b]	Spread ratio[c]	Spread factor[d]
100% wheat flour72% extraction biscuits (control)	3.6	0.9	4.0	100
40% fortified wheat biscuits with semolina	6.0	0.6	10	250
50% fortified wheat biscuits with semolina	6.0	0.6	10	250

a Width of 5 biscuits in series.b Thickness of 5 biscuits in series.
c Width/thickness.d $\frac{\text{Spread ratio of sample}}{\text{Spread ratio of control}} \times 100$.

Fig.(1): 100% wheat flour-72% extraction biscuits.

Fig.(2): 40% semolina fortified wheat biscuits.

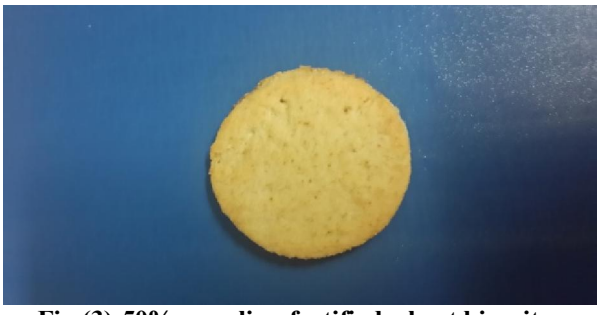

Fig.(3):50% semolina fortified wheat biscuits.

4.2. Sensory characteristics of biscuits:

The sensory characteristics of the studied wheat biscuits as influenced of incorporation of 40% and 50% semolina are outlined in Table (3). The data revealed that both fortified wheat biscuits with 40% and 50% semolina improved all studied sensory characteristics. Such data are in good agreement Taha *et al*. (1992), Perssani *et al*. (2000), Samman *et al*. (2006), and Salama (2008) findings.

Table (3): Sensory characteristics of 100% wheat flour 72% extraction biscuits (control) and wheat flour biscuits fortified with 40% and 50% semolina*.

Biscuit samples	Color	Texture	Taste	Odor	Overall acceptability
100% wheat flour72% extraction biscuits (control)	7.50	7.50	7.50	8.00	7.5
40% fortified wheat biscuits with semolina	8.0	7.5	8.0	8.0	8.0
50% fortified wheat biscuits with semolina	8.0	7.8	8.0	8.0	8.0

* Mean of ten replicates.

4.3. Gross chemical composition of biscuits:

The mean value of gross chemical composition and caloric value of wheat biscuits and fortified wheat biscuits with 40% and 50% semolina are given in Table (4). The data revealed that incorporation of 40% semolina in wheat flour biscuits increased the ash and carbohydrates contents, but decreased both fat and caloric values. However, 50% semolina supplemented wheat biscuits increased ash, carbohydrates and crude fiber contents, but decreased both fat and caloric values. Such data are in good accordance with Shujaat *et al*. (1994), Grewal *et al*. (1999), and Samaan *et al*. (2006) findings.

Table (4):Gross chemical composition and caloric value of wheat flour 72% extraction biscuits and 40%, 50% semolina fortified biscuits (on dry weight basis)*.

Biscuits samples	Moist-ure	Ash	Protein	Fat	Crude fiber	Total carbo-hydrates	Caloric value**
Wheat flour 72% extraction biscuits (control)	9.50	0.98	8.84	12.80	0.00	78.18	463.28
40% fortified biscuits with semolina	2.25	1.96	8.75	7.60	0.00	81.69	430.16
50% fortified biscuits with semolina	1.50	2.00	8.33	8.66	1.00	80.01	431.30

* Mean of three replicates.
** 1 Kcal./100 g.

4.4. Minerals composition of biscuits:

The mean values of mineral composition of wheat biscuits and 40% and50% semolina fortified biscuits are outlined in Table (5). The data revealed that 40% semolinafortified biscuits increased Mn and K contents, while 50% semolina fortified biscuits increased Mn and Na contents. On the other hand, both 40% and 50% semolina fortified biscuits reduced Ca, Cu, and P contents. Such data coincide with Meuser *et al*. (1981), Szalay and Muranyi (1982), Bahnassey *et al*. (1988), and Grewal *et al*. (1999).

Table (5): Mineral content of wheat flour 72% extraction biscuits and 40%, 50% semolina fortified biscuits (on dry weight basis)*.

Biscuit samples	Mn mg/kg	Ca mg/kg	Fe mg/kg	Cu mg/kg	P mg/kg	Na mg/kg	K mg/kg
Wheat flour 72% extraction biscuits (control)	4.78	2034	126.88	2.32	1352.86	4894	2583
40% semolina wheat flour fortified biscuits	6.26	1583	126.36	0.94	1219.90	4700	2607
50% semolina wheat flour fortified	5.31	1205	117.25	0.00	1313.57	5981	2385

* Mean of three replicates.

4.5. Vitamins content of biscuits:

The data outlined in Table (6) represented the mean values of vitamins content in wheat biscuits and 40% and 50% semolina fortified biscuits. The data revealed that 40% semolinafortified biscuits increased vitamin C, Folic acid, and E contents, while 50% semolinafortified biscuits increased vitamin C, Folic and, E, vitamin A contents. Such data are in agreement with Cirilli (1971), and Golovinski (1979).

Table (6):Vitamin content of wheat flour 72% extraction biscuits and 40%, 50% semolina fortified wheat flour biscuits (on dry weight basis)*.

Biscuit samples	Vitamin C mg/100g	Folic acid mg/100g	Vitamin A mg/100g	Vitamin E mg/100g
100% Wheat 72 extraction biscuits (control)	1.65	0.063	1005.40	1.00
40% fortified wheat biscuits with semolina	2.20	0.069	1105.00	3.00
50% fortified wheat biscuits semolina	2.20	0.080	2273.40	2.30

* Mean of three replicates.

4.6. Amino acids content of biscuits:

The amino acid composition data of wheat biscuits and 40% and50% semolina fortified biscuits are presented in Table (7). The outlined data revealed that both 40% and 50% semolina fortified biscuits reduced in general the studied amino acids. The data are in agreement with Bahnassey *et al*. (1988), Gerwat and Hira (2002), and Abdel-Aal and Hucl (2002) findings.

Table (7): Amino acid composition of wheat flour 72 extraction biscuits and 40% and 50% semolina fortified wheat flour biscuits g/100 g protein (on dry weight basis).

Biscuits samples	Isoleucine	Leucine	Lysine	Methionine	Phenyl-alanine	Threonine	Tryptophan	Valine
Wheat flour 72% extraction biscuits (control)	4.67	7.77	3.26	1.99	5.66	0.81	1.39	5.54
40% fortified wheat biscuits with semolina	2.69	5.01	2.07	1.27	2.51	0.67	0.62	2.95
50% fortified wheat biscuits with semolina	2.58	5.44	2.67	1.95	3.14	1.01	0.72	3.96

In conclusion, 50% semolina fortified biscuits proved to be nutritious functional and healthful food. It could be recommended for caloric reduced diets for diabetic, obese and over-weight persons. Likewise, it should be used as an ingredient in the bakery industry such as functional food and healthy foods formulations as biscuits, bread, snack foods, breakfast foods and cakes.

References

1. Matveef, M. (1969). Study on the granual and physico-chemical properties of industrial semolina. Bulletin des AnciensEleves de l'Ecole Francaise de Meunerie, 230, 75-82.
2. Zaitsev, V.I., Khomets, V.G., and Chmeleva, Z.V. (1979). Nitrogen compounds of wheat and its products. Soviet Standard, 12.
3. Pomeranz, Y. (1983). Buckwheat: structure, composition and utilization. CRC Critical Review in Food Science and Nutrition. 19, (3): 213-258.
4. Krelowska-Klaus, M. (1992). Studies on trace elements content in some cereal products. Nahrung. 36, (3): 269-272.
5. Yaseen, A.A.E. (1993). Effect of processing conditions and cooking on retention of minerals in minerals in macaroni. Nahrung. 37, (5): 449-455.
6. Grover, K., Sadana, B.K., and Hira, C.K. (1994). Availability of trace minerals from cereal preparations. Indian Food Packer. 48 (2): 39-44.
7. Shujaat, A., Shahidu, W., Abdul, M., Ismat, F. and Hussain, Q.I. (1994). Evaluation of trace elements in wheat and wheat by-products. Journal of the AOAC International, 77, (1): 11-18.
8. Grewal, H.K., Hira, C.K., and Kawatra, B.L. (1999). Zinc, calcium and iron availability using molar ratios in processed and cooked wheat products. Journal of Food Science and Technology, India, 36, (5): 453-456.
9. Samaan, J., El-Khayat, G.H., Manthey, F.A., Fuller, M.P., and Brennan, C.S. (2006). Durum wheat quality: II- The relationship of kernel physico-chemical composition to semolina quality and end product utilization. International Journal of Food Science & Technology. 41, (Suppl. 2): 47-55.
10. Carnovale, E. and Quaglia, G.B. (1973). Effects of storage at controlled temperature and humidity on the composition of milling products of millet. Annals de Technologie Agricole. 22 (3): 371-380.
11. Bahnassey, Y., Khan, K., and Harrold, R. (1986). Fortification of spaghetti with edible legumes. I-Physico-chemical, antinutritional, amino acid, and mineral composition. Cereal Chemistry. 63, (3): 210-215.
12. Gerwat, H.K. and Hira, C.K. (2001). Effects of processing and cooking on the amino acids of wheat. Journal of Food Science & Technology. India. 38, (3): 632-634.
13. Abdel-Aal, E.S.M. and Hucl, P. (2002). The amino acid composition and in vitro protein digestibility of selected ancient wheats and their end products. Journal of Food Composition and Analysis. 15, (6): 737-747.
14. Pasqualone, A., Caponio, F., Digesu, A.M. and Simeone, R. (2006). Technological characteristics variability of bread-making re-milled semolina. Tecnica Molitoria. 57, (8): 865-869.
15. Peressini, D., Sensidoni, A., Polini, C.M. and Cindio, B, de (2000). Rheology of wheat doughs for fresh pasta production: influence of semolina-flour blends and ash content. Journal of Texture Studies. 31, (2): 163-182.
16. Meuser, F., Schilling, M., and Abds, H. (1981). Determination of the distribution of trace elements in cereal grain. Getreide, Mehl and Brot. 35, (8): 208-211.

17. Sazalay, A. and Muranyi, A. (1982). Micronutrient content of some cereal and cereal products. Acta Alimentaria. 11, (4): 351-362.
18. Cirilli, G. (1971). Nutritional evaluation of flours and semolina with reference to extraction rate. Tecica Molitoria. 22, (18): 586-588.
19. Goloviniski, M.V. (1979). Food concentrates containing semolina and having high nutritive value. Konservnaya i Ovoshchesushil'naya Promyshlennost. (No. 1): 27-28.
20. Foschia, M., Peressani, D., Sensidoni, A., Brennan, M.A., and Brennan, C.S. (2014). Mastication of masceration: does the preparation of sample affect the predictive in vitro glycemic response of pasta. Starch/Staerke. 66, (11): 1096-1102.
21. Grewal, H.K. and Hira, C.K. (2001). Effects of processing and cooking on the amino acid composition of wheat. Journal of Food Science & Technology. India, 38, (6): 632-634.
22. Alexa, E., Voica, V.D., Stoin, D., Poinana, M. and Cocah, I. (2009). Dietary floury aliments enriched with iron. Journal of Agroalimentary Processes and Technologies. 15, (3): 452-455.
23. Martinez-Villaluenga, C., Torres, A., Frias, J., and Vidal-Valverde, C. (2010). Semolina supplementation with processed lupin and pigeon pea flours improve protein quality of pasta. LWT. Food Science & Technology. 43, (4): 617-622.
24. Mehrajafatema, Z.M., Vikas, R.B., Uday, S.A., and Rekha, S.S. (2011). Effect of formulation and processing parameters on acrylamide formation: a case study on extrustion on blends of potato flour and semolina. LWT-Food Science and Tehcnology. 44 (7): 1643-1648.
25. Rao, H. and Manohar, S. (1999). Effects of emulsifier fat level and type on the rheological characteristics of biscuit dough and quality of biscuit. Journal Science of Food and Agriculture, 79: 1233-1231.
26. Saba, N.H. (1997). Culinary is science and Art. P. 685. Dar El-Maaref, Cairo (In Arabic).
27. Vatsala, C.N. and Hardias Rao, P. (1991). Studies on invert sugar for use in biscuits. J. Food Sci. and Techn. 28: 149-152.
28. Manohar, R.S. and Rao, H. (1997). Effect of mixing period and additives on the rheological characteristics of dough and quality of biscuits. J. of Cereal Science, 25: 197-206.
29. Larmond, E. (1977). Laboratory methods of sensory evaluation of food. Canadian Government Publishing Center, Ottawa.
30. A.O.A.C. (2010). Official Methods of Analysis of Association of Official Analytical Chemists. 18th Edition, Washington, D.C., USA.
31. Seleet, R. (2010). The analysis of nutrients in foods. Academic Press. Inc. London. GB.
32. Isaac, R.A. and Johnson, W.A. (2002). Elemental analysis of plant tissue by plasma emission spectroscopy. Collaborative study. J. Assoc. of Anal. Chem., Vol. 68, No. 3, p. 499.
33. A.O.A.C. (2005). Official Methods of Analysis of Association of Official Analytical Chemists. 18th Edition. Washington, D.C. USA.
34. A.O.A.C. (2012). Official Methods of Analysis of Association of Analytical Chemists. 19th Edition. Washington. D.C. USA.
35. Ordriozola-Serrano, I., Hernandez, T. and Bellso, O.M. (2007). Determination of vitamin C. J. Food Chemistry, Vol. 135 (3), p. 1151-1158.
36. Albala-Hurtado, S., Veciana-Nugues, M.T., Izquierdo-Pulido, M. and Marine-Font, A. (1997). Determination of folic acid. J. Chromatography, A, 778, 247.
37. Gomis, P.B., Fernadert, M.P., Cuttewe, M.D. and Alverrez, I. (2000). Determination of vitamin A and vitamin E. J. Chromatography, A. 891, 105-114.
38. Baxter, J.H. (1996). Amino acids. In Handbook of Food Analysis. Vol. I edited by Leo, M.L. Nollet. Marcel Dekker. Inc., New York, p. 179-228.
39. Sastry, C. and Tummuru, M. (1995). Spectrophotometric determination of tryptophan in protein. J. Food Science Technology, 22, 146-147.
40. Taha, S.A., Kovacs, Z. and Sagi, F. (1992). Evaluation of economical pasta products prepared from durum semolina/yellow corn flour/soy flour mixtures. II. Cooking behaviour, firmness and organoleptic properties. Acta Alimentaria. 21 (2): 163-170.
41. Salama, M.F. (2008). Preparation and evaluation of pasta prepared from semolina flour and oyster mushroom mycelia powder. Egyptian Journal of Food Science, 35, 59-70.

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