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ORIGINAL ARTICLE

Influence of resistant starches on chemical and functional properties of tarhana

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Abstract Two different commercial resistant starches (RSa and RSb) were used in tarhana formulation on the basis of its replacement with wheat flour at 15, 30 and 45 % levels. Color values, some chemical, functional and sensory properties of tarhana were determined. Tarhana containing 30–45 % RSa gave lower darkness and yellowness compared to other samples. Increasing levels of RSa/RSb in tarhana formulation decreased protein and Fe, K, Mg, P and Zn content of the final products. Development in acidity was negatively affected above 30 % RS addition level. Although long fermentation period of tarhana dough, RS content of the tarhana samples changed between 5.4 and 26.2 %. Control tarhana was found to have 0.9 % RS content. Cooked viscosity decreased in tarhana soup with RS addition from 1,454 cP (control) to 166 cP. RSb showed more remarkable effect on cooked viscosity than RSa. High levels of RSa improved foaming capacity, foam stability, water and oil absorption capacity of the tarhana samples. RSa successfully incorporated into tarhana formulation up to 30 % level with minimum adverse effect on chemical and sensory properties.

Research highlights
1. Two different resistant starches (RSa and RSb) were used in tarhana up to 45 % level.
2. Tarhana with 30–45 % RSa gave lower darkness and yellowness compared to other samples.
3. Increasing levels of RSa/RSb in tarhana decreased protein and Fe, K, Mg, P and Zn content.
4. RS content of the tarhana samples changed between 5.4 and 26.2 %.
5. Cooked viscosity decreased in tarhana soup with RS addition, especially with RSb.

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Introduction

Resistant starch (RS) is a portion of starch and starch products that resist to digestion of body enzyme. European Flair Concerted Action on Resistant Starch (EURESTA) has defined RS as the starch or products of starch degradation that escapes digestion in the small intestine of healthy individuals and may be completely or partially fermented in the colon (Englyst et al. 1992). RS is subdivided into four fractions: physically inaccessible to pancreatic α-amylase (RS1), amylopectin crystals of uncooked native starch granules (RS2), retrograded starch (amylase crystals) (RS3) (Englyst and Cummings 1987) and thermally or chemically modified starch (RS4) (Eerlingen et al. 1995). RS reduces the risk of colonic cancer, diabetes, gall stone formation, obesity related complications and atherosclerosis (Sajilata et al. 2006; Fuentes-Zaragoza et al. 2010). Because of RS has lower impact on the sensory properties of foods compared with traditional sources of fibres (Fuentes-Zaragoza et al. 2010), RS has been used for increasing functional quality of breads (Korus et al. 2009; Öztürk et al. 2009), muffins and cake (Lin et al. 1994; Baixauli et al. 2008a, b), spaghetti and pasta (Sözer et al. 2007; Aravind et al. 2013), biscuits and cookie (Aparacio-Saguilán et al. 2007; Laguna et al. 2011; Agama-Acevedo et al. 2012), granola bars and cereals (Aigster et al. 2011).

Tarhana is a popular fermented food product, and generally consumed as thick soup in Turkey. It is prepared with mixing yoghurt, wheat flour, yeast and a variety of cooked vegetables and spices followed by fermentation for 1 to 7 days (Siyamoğlu 1961; Campbell-Platt 1987; Bilgiçli et al. 2006a). Tarhana provides an increased digestibility and nutritional benefit owing to its high biological value proteins and prolonged fermentation process (Bilgiçli et al. 2006b). The same as tarhana there are some other products like kishk in Syria, Jordan and Egypt (Youssef 1990) and kushuk in Iraq (Alnouri and Duitschaever 1974).

The objective of this study was to determine the effect of RS on some chemical, functional and sensory properties of tarhana.

Materials and methods

Materials

The ingredients used in tarhana preparation were obtained from local markets in Konya, Turkey. To prepare tarhana, commercial wheat flour, concentrated full fat yoghurt that was made of cow's milk, tomato paste (32°Bx), onion, paprika (powder form), bakers' yeast and salt were used. RSa and RSb are type 3 commercial resistance starches. RS content of commercial RSa and RSb were 47 and 64 %, respectively.

Methods

Tarhana production

To prepare control tarhana sample, wheat flour (200 g), yoghurt (80 g), tomato paste (20 g), chopped onions (10 g), paprika (4 g), yeast (5 g), salt (2 g) and water were mixed in a Hobart Mixer. After mixing of ingredients, the dough was incubated at 30 °C for 72 h in the plastic containers and dried at 55 °C for 48 h in an air convection oven (Özköseoğlu PFS-9, Turkey). Dried samples were ground in a hammer mill equipped with 1 mm opening screen (Bilgiçli et al. 2006a). Tarhana samples containing RSa or RSb were prepared as described above with the replacement of 15, 30 and 45 % (w/w) RSa or RSb with wheat flour. Tarhana samples were kept in polyethylene bags at room temperature until used.

Chemical analyses

The AACC methods were used for determination of ash and protein contents of the tarhana samples (AACC 1990). RS content of the tarhana samples were measured using the Megazyme resistant starch kit (Megazyme Int., Wicklow, Ireland) according to Approved Method 32–40 (AACC 2004). The total titratable acidity of dried and ground samples was calculated as lactic acid as described by Kirk and Sawyer (1991). The mineral content were determined by an ICP-AES (Vista series, Varian International AG, Switzerland) as explained by Bubert and Hagenah (1987). The instrument was operated with a radiofrequency power of 0.7–1.5 kW (1.2–1.3 kW for axial); plasma gas flow rate (Ar) of 10.5–15 L/min (radial), 15 L/min (axial); auxiliary gas flow rate (Ar) of 1.5 L/min; viewing height of 5–12 mm; copy and reading time of 1–5 s (maximum of 60 s); and copy time of 3 s (maximum of 100 s).

Color measurement

Color (L*, a* and b*) measurement was made using a Minolta Chroma Meter CR-400 (Minolta, Osaka, Japan). L* corresponds to light/dark chromaticity, a* to green/red chromaticity and b* to blue/yellow chromaticity. The instrument was calibrated with a white reference tile before the measurements. Hue angle (hue) (arctan [b*/a*]) and the saturation index (SI) ($[a^{*2} + b^{*2}]^{1/2}$) values were calculated using a* and b* values.

Functional properties

Viscosity Tarhana powder (20 g) was mixed with 200 mL distilled water (20 °C) and simmered for 12 min over medium heat with constant stirring. The viscosity of soup was then measured at 100 rpm and 60 °C using a rotational Brookfield viscometer (Brookfield RTV, spindle no: 5) as described by Ibanoğlu et al. (1995) and Hayta et al. (2002).

Water absorption capacity and oil absorption capacity Tarhana (5.0 g) was mixed with distilled water (25 mL) or sunflower oil in 50 mL centrifuge tubes. The mixture was stirred (15 min intervals over a 60 min period) and then centrifuged (4,000×*g* for 20 min). Water and oil absorption capacity values were expressed as grams of water or oil absorbed per gram of tarhana (Hayta et al. 2002).

Foaming capacity and foam stability Tarhana (10 g) was dispersed in distilled water and stirred (20 min), and then centrifuged (4,000×*g* for 20 min). Supernatant whipped for 2 min at high-speed of Waring blender. The solution was slowly poured into a cylinder, and the volume of the foam was recorded after 10s. Foaming capacity was expressed as the volume (mL) of gas incorporated per mL of solution. Foam stability was recorded as the time passed until the half of the original foam volume had disappeared (Hayta et al. 2002).

Sensory analysis

Tarhana soups, prepared as described in viscosity section, were subjected to sensory evaluation. Twenty five panelists were asked to score the soups in terms of color, flavor, consistency, cohesiveness, sourness and overall acceptability using nine point hedonic scale with 1- dislike extremely, 2- dislike very much, 3- dislike moderately, 4- dislike slightly, 5- neither like nor dislike, 6- like slightly, 7- like moderately, 8-

Table 1 Color values of tarhana samples

	L*	a*	b*	SI	Hue
Control	81.01±0.48^{c}	5.92±0.10^{b}	27.31±0.23^{ab}	27.94±0.20^{ab}	77.77±0.45^{abc}
15 % RSa	84.24±0.30^{b}	4.90±0.14^{c}	25.16±0.23^{c}	25.63±0.34^{c}	78.98±0.47^{a}
30 % RSa	86.09±0.28^{a}	4.77±0.17^{c}	24.22±0.31^{d}	24.69±0.21^{d}	78.86±0.58^{ab}
45 % RSa	86.92±0.47^{a}	4.81±0.16^{c}	23.85±0.34^{d}	24.33±0.24^{d}	78.60±0.51^{abc}
15 % RSb	81.56±0.44^{c}	6.08±0.10^{b}	27.30±0.27^{ab}	27.97±0.41^{ab}	77.44±0.45^{cd}
30 % RSb	81.80±0.37^{c}	6.64±0.18^{a}	27.58±0.35^{a}	28.37±0.18^{a}	76.46±0.48^{d}
45 % RSb	81.15±0.42^{c}	5.88±0.18^{b}	26.90±0.23^{b}	27.54±0.55^{b}	77.67±0.58^{bcd}

Means with same letter within column are not significantly different ($p<0.05$). *RS*: Resistant starch

like very much, 9- like extremely. The samples were coded with numbers and served to the panelists at random to guard against any bias.

Statistical analyses

Statistical analyses were performed using the Statistical software JMP 5.0.1 (SAS Institute). Means were compared at 5 % confidence interval

Results and discussion

Color values of tarhana

Color is an important quality parameter for powder and soup form of tarhana. Traditionally, many types of tarhana are produced with different ingredients in Turkey. These tarhana samples have a very rich variety of colors due to different cereal, dairy products, vegetables and spices in dough formulation. In present study, color values of tarhana samples are given in Table 1. RSa gave higher lightness but lower redness, yellowness and SI values on tarhana compared to control and tarhana containing RSb. Color values of commercial RSa (L* 98.30, a* 0.05 and b* 1.37) and RSb (L* 89.44, a* 0.62 and b* 10.16) could have a significant effect on color parameters of final product. In literature, there are some studies about the effect of RS on product color parameters which is generally decreased darkness, redness and yellowness of the final products (Sözer 2006; Laguna et al. 2011).

Chemical properties of tarhana

Chemical properties of tarhana samples are given in Table 2. Increasing level of RSa/RSb in tarhana formulation decreased the ash content of the samples descriptively, but a significant ($p<0.05$) decrease observed in ash content only tarhana containing 45 % RSb. Both RS samples decreased the protein content of the tarhana from 13.7 % (control) to 11.0 % (RSa) and 11.2 % (RSb) with 45 % utilization levels. Low protein content of RSa/RSb than wheat flour may be cause lower protein content in tarhana samples.

Acidic and sour taste is main characteristic properties of tarhana. Acidity improves during fermentation of tarhana dough (˜72 h) by means of lactic acid bacteria from yoghurt and yeast from compressed bakers' yeast. Tarhana samples containing 30–45 % RSa/RSb had lower acidity among tarhana samples. Especially 45 % RSb caused most remarkable decrement in acidity from 1.89 % (control) to 1.49 %

Table 2 Chemical properties of tarhana samples

	Ash (%)	Protein (%)	Acidity (%)	Resistant starch (%)	Fe (mg/100 g)	K (mg/100 g)	Mg (mg/100 g)	P (mg/100 g)	Zn (mg/100 g)
Control	2.45±0.08^{a}	13.7±0.28^{a}	1.89±0.06^{a}	0.9±0.03^{g}	1.25±0.03^{a}	538.3±1.84^{a}	40.6±0.57^{a}	198.2±1.70^{a}	1.21±0.02^{a}
15 % RSa	2.41±0.08^{a}	12.8±0.42^{b}	1.81±0.06^{ab}	5.4±0.03^{f}	1.13±0.04^{b}	512.0±2.83^{b}	36.6±0.85^{b}	180.2±2.55^{b}	1.10±0.03^{b}
30 % RSa	2.39±0.06^{ab}	11.7±0.28^{cd}	1.73±0.04^{b}	11.9±0.14^{d}	1.03±0.05^{c}	491.0±1.41^{d}	32.3±1.84^{c}	158.4±2.26^{c}	1.02±0.04^{c}
45 % RSa	2.32±0.10^{ab}	11.0±0.28^{d}	1.70±0.04^{bc}	19.6±0.14^{b}	0.88±0.04^{d}	471.0±2.83^{e}	29.1±1.27^{d}	140.3±2.40^{e}	0.91±0.01^{d}
15 % RSb	2.37±0.04^{ab}	12.7±0.14^{b}	1.93±0.04^{a}	8.2±0.07^{e}	0.98±0.04^{c}	504.0±4.24^{c}	35.0±1.39^{bc}	175.0±2.83^{b}	1.05±0.01^{bc}
30 % RSb	2.33±0.06^{ab}	11.9±0.28^{c}	1.58±0.08^{cd}	18.2±0.03^{c}	0.78±0.01^{e}	471.0±1.41^{e}	29.1±1.27^{d}	147.0±2.83^{d}	0.94±0.03^{d}
45 % RSb	2.21±0.10^{b}	11.2±0.42^{cd}	1.49±0.04^{d}	26.2±0.14^{a}	0.60±0.04^{e}	435.0±2.83^{f}	25.5±0.71^{e}	130.0±1.41^{f}	0.82±0.04^{e}

Means with same letter within column are not significantly different ($p<0.05$). Results are dry matter basis

RS: resistant starch

Table 3 Functional properties of tarhana samples

	Cooked viscosity (cP)	Foaming capacity (mL/mL)	Foam stability (sec)	Water absorption capacity (g/g)	Oil absorption capacity (g/g)
Control	1454±33.94^{a}	0.40±0.04^{c}	0.80±0.06^{c}	0.75±0.03^{c}	1.84±0.06^{bc}
15 % RSa	1210±25.46^{b}	0.44±0.06^{c}	0.83±0.04^{bc}	0.91±0.03^{b}	1.95±0.07^{b}
30 % RSa	895±28.28^{c}	0.61±0.04^{b}	0.88±0.04^{abc}	0.90±0.04^{b}	2.18±0.04^{a}
45 % RSa	795±21.21^{d}	0.89±0.06^{a}	0.92±0.03^{ab}	1.12±0.03^{a}	2.27±0.03^{a}
15 % RSb	776±29.70^{d}	0.43±0.04^{c}	0.83±0.04^{bc}	0.71±0.04^{c}	1.80±0.04^{c}
30 % RSb	288±19.80^{e}	0.47±0.06^{c}	0.83±0.04^{bc}	0.91±0.03^{b}	1.78±0.04^{c}
45 % RSb	166±21.21^{f}	0.50±0.04^{bc}	0.95±0.06^{a}	0.90±0.01^{b}	1.75±0.06^{c}

Means with same letter within column are not significantly different ($p<0.05$). *RS*: Resistant starch

which influenced the sensory acceptability of the tarhana soup (Table 4). Decrement in the acidity of tarhana containing RS may be attributed the low available carbohydrate content of these samples for growing of microorganisms. RS content of the samples varied between 0.9 and 26.2 %. As expected increasing amount of RSa/RSb in tarhana formulation, increased the RS ratio in the end product. Commercial RSa and RSb samples contains 47 and 64 % RS, respectively (data not shown). During tarhana fermentation, RS survived its properties and only a slight decrease was observed in RS content compared to raw material RS ratio with its usage levels. Öztürk et al. (2009) used three different commercial RS in bread formulation at 10, 20 and 30 % level and found the RS level of final product between 3.97 and 10.23 %. Mineral content of the tarhana samples containing RS decreased with increasing amount of RSa/RSb in tarhana formulation. RSb at 45 % level decreased Fe, K, Mg, P and Zn contents of the tarhana samples from 1.25 mg/100 g, 538.3 mg/100 g, 40.6 mg/100 g, 198.2 mg/100 g and 1.21 mg/100 g (control) 0.6 mg/100 g, 435.0 mg/100 g, 25.5 mg/100 g, 130.0 mg/100 g and 0.82 mg/100 g, respectively. Rich mineral composition of wheat flour than RS caused these decrement especially at high addition levels.

Functional properties of tarhana

Some functional properties of tarhana are summarized in Table 3. Cooked viscosity of the tarhana samples decreased with increasing amount of RSa/RSb in tarhana formulation. The lowest cooked viscosity values obtained with 45 % RSb and followed with 30 % RSb and 45 % RSa or 15 % RSb. Tímea Gelencsér et al. (2008) determined viscometric characteristics of the pasta products using rapid visco analyzer (RVA) and reported a significant ($p<0.05$) reduction in RVA parameters (peak viscosity, trough, breakdown, setback, and final viscosity) of pasta products that were substituted with RS. Also, Baixauli et al. (2008b) reported a decrement in viscosity of muffins dough substituted with 20 % RS. Foaming capacity increased with 30–45 % RSa compared to control and RSb containing tarhana. Foam stability affected positively with the highest addition level of RSa/RSb. Water absorption capacity of tarhana increased with RSb above 30 % addition levels, while it increased in all addition level of RSa. Öztürk et al. (2009) also found that water absorption of bread dough increased with increasing RS ratio in dough formulation. Oil absorption of tarhana was not affected negatively by RS addition, which the obtained oil absorption values of tarhana containing RS were similar or higher compared to control tarhana. Functional properties are important for

Table 4 Sensory scores of tarhana samples

	Color	Flavor	Consistency	Cohesiveness	Sourness	Overall acceptability
Control	8.5±0.28^{a}	9.0±0.14^{a}	8.6±0.42^{a}	9.0±0.42^{a}	9.0±0.42^{a}	9.0±0.42^{a}
15 % RSa	9.0±0.71^{a}	8.8±0.14^{a}	8.1±0.14^{a}	9.0±0.14^{a}	8.7±0.28^{a}	8.8±0.42^{a}
30 % RSa	8.1±0.28^{ab}	8.1±0.28^{b}	7.7±0.28^{a}	8.1±0.42^{b}	8.3±0.42^{a}	7.7±0.28^{b}
45 % RSa	7.2±0.28^{bc}	7.2±0.28^{c}	6.3±0.42^{b}	7.2±0.28^{c}	7.2±0.28^{bc}	6.5±0.42^{c}
15 % RSb	9.0±0.14^{a}	7.2±0.28^{c}	6.3±0.42^{b}	6.5±0.28^{c}	7.4±0.28^{b}	7.3±0.28^{b}
30 % RSb	7.2±0.28^{bc}	6.3±0.42^{d}	5.9±0.57^{b}	5.4±0.28^{d}	6.5±0.14^{c}	6.3±0.14^{c}
45 % RSb	6.3±0.42^{c}	5.4±0.28^{e}	3.1±0.57^{c}	4.5±0.42^{e}	4.5±0.28^{d}	4.5±0.28^{d}

Means with same letter within column are not significantly different ($p<0.05$)

RS: resistant starch

process design, sensory quality and consumer acceptability. In tarhana process, drying methods (İbanoglu et al. 1999; Hayta et al. 2002) fermentation, storage (İbanoğlu et al. 1995; Bulut-Solak and Akın 2011), heating temperatures, heating time, heating type (Boye et al. 1997) and different tarhana ingredients (Bilgiçli 2009; Gökmen 2010) affect the functional properties of tarhana.

Sensory properties of tarhana

Sensory properties of the tarhana soups are shown in Table 4. Color properties of tarhana containing 45 % RSa or 30–45 % RSb were evaluated lower values by the panelist. Flavor of tarhana was negatively affected by all level of RSa/RSb usage except 15 % RSa level. Tarhana containing RSb gave lower consistency score compared to control and tarhana with RSa. As observed in cooked viscosity value (Table 3), tarhana containing highest level of RS with lower viscosity was feeled by the panelists and evaluated by lower consistency scores. Low sourness value obtained in tarhana containing 45 % RSa or all level of RSb. As stated before, acidity of the tarhana decreased with RS above 30 % addition level. This change in acidity was evaluated by the panelist by lower sourness scores. Overall acceptability score of tarhana samples changed between 4.5 and 9.0. Generally RSb containing tarhana samples gave lower overall acceptability score than tarhana with RSa and control. 15 % RSa addition did not changed overall acceptability of tarhana soup, 30 % RSa and 15 % RSb levels followed this samples with slight decrement in overall acceptability scores. Laguna et al. (2011) enriched biscuits with different rates of RS (15–70 %) and found that the acceptance scores for the control and biscuit with 20 % RS were not significantly different for any of the sensory attributes. Baixauli et al. (2008a) reported that there were no significant differences in the taste and overall acceptability of the muffins with the addition of RS. In another study, different levels of RS (%10, 20, 30 and 40) replaced with fat in cookie formulation to reduce fat content of the final product. 30 % addition level of RS reduced fat content of cookies and acceptable cookie production were achieved (Şeker et al. 2006).

Conclusion

Effect of two different commercial RS up to 45 % addition level on color values, chemical, functional and sensory properties of tarhana were researched. Increasing levels of RSa/RSb in tarhana formulation decreased some chemical properties such as protein and Fe, K, Mg, P and Zn content. Acidity was negatively affected above 30 % RS addition level due to lower available carbohydrate content of the tarhana dough for microorganisms. Though long fermentation period of tarhana dough, RS content of the tarhana samples was found very high level (5.4 and 26.2 %). Both RS decreased the cooked viscosity of tarhana soup, on the other hand functional properties except viscosity improved with high levels of RSa. When all chemical, functional and sensory properties of tarhana were taken into account, RSa can be used in tarhana preparation up to 30 % level and RSb at 15 % for RS enrichment.

References

AACC (1990) Approved methods of the American Association of Cereal Chemists, 8th edn. AACC, St Paul

AACC (2004) Approved methods of the American Association of Cereal Chemists, 10th edn. AACC, St Paul

Agama-Acevedo E, Islas-Hernández JJ, Pacheco-Vargas G, Osorio-Díaz P, Bello-Pérez LA (2012) Starch digestibility and glysemic index of cookies partially substituted with unripe banana flour. LWT Food Sci Technol 46:177–182

Aigster A, Duncan SE, Conforti FD, Barbeau WE (2011) Physicochemical properties and sensory attributes of resistant starch-supplemented granola bars and cereals. LWT Food Sci Technol 44:2159–2165

Alnouri FF, Duitschaever CL (1974) The use of pure cultures for the preparation of kushuk. Can I Food Sci Tech J 7:228–229

Aparacio-Saguilán A, Sáyago-Ayerdi SG, Vargas-Torres A, Tovar J, Ascencio-Otero TE, Bello-Pérez LA (2007) Slowly digestible cookies prepared from resistant starch-rich lintnerized banana starch. J Food Compos Anal 20:175–181

Aravind N, Sissons M, Fellows CM, Blazek J, Gilbert EP (2013) Optimisation of resistant starch II and III levels in durum wheat pasta to reduce in vitro digestibility while maintaining processing and sensory characteristics. Food Chem 136:1100–1109

Baixauli R, Salvador A, Martinez-Cervera S, Fiszman SM (2008a) Distinctive sensory features introduced by resistant starch in baked products. LWT Food Sci Technol 41:1927–1933

Baixauli R, Sanz T, Salvador A, Fiszman SM (2008b) Muffins with resistant starch: baking performance in relation to the rheological properties of the batter. J Cereal Sci 47(3):502–509

Bilgiçli N (2009) Effect of buckwheat flour on chemical and functional properties of tarhana. LWT Food Sci Technol 42:514–518

Bilgiçli N, Elgün A, Herken E, Türker S, Ertaş N, İbanoğlu Ş (2006a) Effect of wheat germ/bran addition on the chemical, nutritional and sensory quality of tarhana. J Food Eng 77:680–686

Bilgiçli N, Elgün A, Türker S (2006b) Effects of various phytase sources on phytic acid content, mineral extractability and protein digestibility of tarhana. Food Chem 98:329–337

Boye JI, Ma CY, Harwalkar VR (1997) Thermal denaturation and coagulation of proteins. In: Damodaran S, Paraf A (eds) Food proteins and their applications. Marcel Dekker, New York, pp 25–56

Bubert H, Hagenah WD (1987) Detection and measurement. In: Boumans PWJM (ed) Inductively coupled plasma emission spectroscopy. Wiley-Interscience Pub, New York, pp 536–567

Bulut-Solak B and Akın N (2011) Some functional properties of traditional Turkish wet tarhana during fermentation and storage. 11th FENS European Nutrition Conference, October, 26th 29th Madrid, Spain (Oral presentation), Annals of Nutrition & Metabolism 11

Campbell-Platt G (1987) Fermented foods of the world. Butterworths, London, pp 253–254

Eerlingen RC, Jacobs H, Delcour JA (1995) Formation, analysis, structure and properties of type III enzyme resistant starch. J Cereal Sci 22:129–138

Englyst HN, Cummings JH (1987) Resistant starch, a new food component: a classification of starch for nutritional purposes. In: Morton ID (ed) Cereals in a European context. First European conference on food science and technology. Ellis Horwood, Chichester, pp 221–233

Englyst HN, Kingman SM, Cummings JH (1992) Classification and measurement of nutritionally important starch fractions. Eur J Clin Nutr 46(Suppl. 2):30–50

Fuentes-Zaragoza E, Riquelme-Navarrete MJ, Sánchez-Zapata E, Pérez-Álvarez JA (2010) Resistant starch as functional ingredient. Food Res Int 43:931–942

Gelencsér T, Gál V, Hódsági M, Salgó A (2008) Evaluation of quality and digestibility characteristics of resistant starch-enriched pasta. Food Bioprocess Technol 1:171–179

Gökmen S (2010) Çiğ, pişmiş ve kurutulmuş ayva katkısının tarhana üzerine olan etkisi, Ulusal Meslek Yüksekokulları Öğrenci Sempozyumu 21–22 Ekim 1–15

Hayta M, Alpaslan M, Baysar A (2002) Effect of drying methods on functional properties of tarhana: a wheat flour–yoghurt mixture. J Food Sci 67:740–744

İbanoğlu Ş, Ainsworth P, Wilson G, Hayes GD (1995) The effect of fermentation conditions on the nutrients and acceptability of tarhana. Food Chem 53:143–147

İbanoglu Ş, İbanoğlu E, Ainsworth P (1999) Effect of different ingredients on fermentation activity in tarhana. Food Chem 64:103–106

Kirk RS, Sawyer R (1991) Pearson's composition and analysis of foods. Longmann Scientific and Technical, Essex

Korus J, Witczak M, Ziobro R, Juszczak L (2009) The impact of resistant strach on characteristics of gluten-free dough and bread. Food Hydrocoll 23(3):988–995

Laguna L, Salvador A, Sanz T, Fizsman MS (2011) Performance of a resistant starch rich ingredient in the baking and eating quality of short-dough biscuits. LWT Food Sci Technol 44:737–746

Lin PY, Czuchajowska Z, Pomeranz Y (1994) Enzyme-resistant starch in yellow layer cake. Cereal Chem 71:69–75

Öztürk S, Köksel H, Ng PKW (2009) Farinograph properties and bread quality of flours supplemented with resistant starch. Int J Food Sci Nutr 60(6):449–457

Sajilata MG, Singhal RS, Kulkarn PR (2006) Compr Rev Food Sci Food Saf 5:1–17

Şeker İT, Gökbulut İ, Öztürk S, Özbaş ÖÖ, Köksel H (2006) Enzyme dirençli nişastanın bisküvi üretiminde kullanımı. Türkiye 9. Gıda Kongresi, Bolu, pp 157–160

Siyamoğlu B (1961) Investigation on the preperation and composition of Turkish tarhana. Ege University Press, Izmir

Sözer N (2006) Rheological properties of spaghetti enriched with resistant starch. Ph.D. Thesis in Food Engineering University of Gaziantep

Sözer N, Dalgıç AC, Kaya A (2007) Thermal, textural and cooking properties of spaghetti enriched with resistant starch. J Food Eng 81:476–484

Youssef MM (1990) Instantisation and evaluation of some traditional Egyptian foods. Food Chem 38:247–254