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Effect of Tomato Pulp Addition on the Functional Properties of Extrudates

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[1]**Abstract.** Effect of addition of tomato pulp on the physical parameters and the effect of extrusion on functional properties of the extrudates were investigated. Corn grits with and without tomato pulp at 30% moisture were extruded. Sectional expansion index, color and sensory analysis were conducted. Tomato pulp addition caused slight increase in the expansion index at two shear rate and caused increase in the redness and some decrease in yellowness. Sensory analysis indicated no significant difference between the pulp added and not added products for appearance, color, crispiness, porosity, and overall preferences. Results indicated that total phenol content decreased from 12.41±0.76 mg/g to 3.39±0.47 mg/g at 125 rpm and to 2.59±1.33 mg/g at 225 rpm, expressed as gallic acid equivalent per gram dry sample with extrusion. Antioxidant activity was not affected by extrusion at the selected conditions. Antioxidant activity of the feed, and extrudates at 125 and 225 rpm were; 15.50±3.02, 15.16±3.60 and 14.72±3.34 µmol/g dry sample expressed as trolox equivalents. Shear rate had no significant effect on either total phenol content or antioxidant activity at the selected conditions.

Keywords: Extrusion, tomato pulp, functional properties, antioxidant activity

1. Introduction

With the development of food technology and improved knowledge of consumers in recent years the customers do not seek for nutritious products only but also search for health promoting foods. This makes the health promoting foods to be popular. Therefore, continuous improvement became essential for the industry. Extrusion process is a reasonable choice for development of functional foods as they produce a wide range of products in different texture and structure. Extruded products are popular among the consumers. Corn based snacks have high starch content. Therefore, these snacks are dense in energy but can be nutritionally poor. This and possibility of producing wide range of products make the process a good candidate for addition of the functional components.

The lack of the nutritional values of the extruded products can be healed by addition of fruits or vegetables. In this study, tomato (*Solanum lycopersicum*) was chosen. Tomato is known by being rich in dietary fiber and carotenoids especially in lycopene. More than 70 % of tomato skin and 15% of tomato paste consists of dietary fiber [1]. Among the benefits of the fiber, the laxation and modulation of blood glucose can be counted. Lycopene is associated with various health benefits including immune system modulation, a free radical scavenger and having anticarcinogen properties [2].

During the extrusion cooking, food materials are subjected to high temperatures and pressures in combination with shearing stresses. As a result, the material undergoes physical and chemical modifications such as gelatinization and breakdown of starch, denaturation of proteins and interactions between their products occur. Moisture content of the feed material, feeding rate, screw speed and configuration, die geometry, temperature and pressure are the extrusion cooking parameters that affect the quality parameters

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of the extruded products. The aim of this research was to investigate the effect of addition of tomato pulp on the physical parameters and the effect of extrusion on functional properties of the extrudates.

2. Material and Methods

2.1. Sample preparation

Feed was prepared for the extrusion process by mixing tomato pulp with corn grits to the moisture content of 30%. The control was prepared by mixing corn grits with distilled water to the same moisture content. Samples in plastic bags were tempered for 24 hours in a cold room before the extrusion process to ensure uniform hydration. Samples were allowed to equilibrate at room temperature for two hours before the extrusion process.

2.2. Extrusion process

A laboratory scale twin screw co-rotating extruder (Feza Gıda Müh. Makine Nakliyat Demir Tic. Ltd. Şti, Turkey) with computer control and data acquisition system was used for the study. The die diameter and the barrel length to diameter ratio (L: D) were 3 mm and 25:1, respectively. The extruder had four heating zones controlled by electrical heating and water cooling. Computerized data acquisition system was used to control the barrel zone temperatures and rotor speed. Barrel zone temperatures were set at; 80°C, 90°C, 115°C and 145°C. Screw speeds of 125, 175 and 225 rpm were used. Feed moisture content and feed flow rate were constant for all studies, 30% and 36 g/min, respectively. The feed was fed to the extruder with a twin screw volumetric feeder which was built in to the extruder system. Extruded samples were dried at 50 ℃ for 5 hr in a tray dryer (UOP8-A, Armfield, England). The final moisture contents of the dried samples were less than 10%. The dried samples were kept in a vacuum jar at room temperature until the analysis.

2.3. Sectional expansion index

Diameters of extrudates were measured at ten different locations with a digital caliper at random and the average was calculated. The sectional expansion index of the extrudates was calculated according to Paiet al [2]:

SEI= $(D_e/D_d)^2$, where D_d: diameter of the die and D_e: diameter of the extrudate.

2.4. Color analysis

Grounded and sieved (212 micron) particles put in the sample holder and were pressed gently as there would not be a space between them. A colorimeter (CR-10, Konica Minolta Optics Inc., Japan) was used to determine color values of the raw and grounded extruded samples in terms of lightness, redness and yellowness (CIE L*, a* and b* values). The colorimeter was calibrated against a standard white calibration plate (L*= 93.8, a*= 0.0, b*= 5.2). For each sample 5 measurements were taken and averaged.

2.5. Sensory Analyses

Sensory analysis of extrudates was performed by 12 semi-trained panelists selected from Food Engineering Department master students. They evaluated the extruded snacks for appearance, color, crispiness, porosity, and overall preferences on a 9 point hedonic scale (1: Dislike extremely to 9: Like extremely). Panelists rinsed their mouths with water after tasting each sample.

2.6. Extraction

12.5 mL of acetone-water mixture (4:1) was added to the 500 mg of feed and grounded extrudates. The mixture was stirred at a rotary shaker for 2 hours. The samples were centrifuged at 3000xg for 12 minutes. The supernatant was collected and filtered through 0.45 μm syringe type filter.

2.7. Total phenolic analysis

Total phenolic contents were determined colorimetrically using Folin–Ciocalteau reagent, as described by Antonet al[3] with some modifications. 0.2 mL of acetone-water extract of the samples was mixed with 1.5 mL of Folin-Ciocalteau reagent (Merck, Germany) which is diluted 10-fold. After 5 minutes of delay, 1.5 mL of Na_2CO_3 (60 g/L) was added. Reagents were allowed to react at room temperature for 90 minutes in dark. The absorbance was read at 725 nm. A standard curve was prepared with Gallic acid (3, 4, 5-

Trihydroxybenzoicacid, Sigma–Aldrich, Germany). The results are expressed in mg Gallic acid equivalent /100 gr dry samples.

2.8. DPPH radical scavenging activity test

Antioxidant activities of the feed and extrudates were determined with a stable radical, 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as described by Anton*et al* [3] with some modifications. 200 μL of acetone-water extract was added to 3.8 mL of 63 μM DPPH (Sigma–Aldrich, Germany). The extracts were left at dark for 1 hour. The absorbance was read at 517 nm. A standard curve was prepared with trolox (6-hydroxy-2, 5, 7, 8-tetramethylchroman-2-carboxylic acid from Sigma–Aldrich, Germany), a synthetic, hydrophilic vitamin E analogue, as an external standard with a range of concentrations from 10μM to 100 μM. Results were expressed as trolox equivalents/gr dry sample.

3. Results and Discussions

Effect of addition of tomato pulp on the expansions of extrudates was investigated for three last zone temperatures of 130, 145 and 160 ℃ respectively. Both pulp added and not added samples showed highest expansion at 145 ℃ last zone temperature (data are not shown). According to data (Table 1) at this temperature set (80, 90, 115, 145 ℃), adding tomato pulp to the corn grit slightly increased the sectional expansion index at two screw speeds (125 and 225 rpm) but did not show statistically significant difference at 175 rpm. Color analysis indicated that lightness did not change significantly (Table 1). Tomato pulp added samples showed higher redness, a*, values and lower yellowness, b*, values (Table 1). Sensory analysis indicated that there were not significant differences between the appearance, taste, color, porosity, crispiness and overall preferences of the corn grit extrudates and extrudates with tomato pulp (Table 2).

Table 1: Physical properties of extrudates with and without tomato pulp, extruded at 145°C last zone temperature and 30% moisture.

Screw Speed (rpm)	Corn Grit	Tomato Pulp Added Corn Grit
	SEI (m^2/m^2)	
125	5.2 ± 1.4^a	8.0 ± 2.0^b
175	6.7 ± 2.1^a	7.4 ± 1.2^a
225	5.1 ± 0.7^a	7.8 ± 0.8^b
	L*	
125	85.8 ± 0.5^a	86.7 ± 0.5^a
175	86.5 ± 0.6^a	86.1 ± 0.7^a
225	87.1 ± 0.6^a	86.8 ± 0.7^a
	a*	
125	3.3 ± 0.3^a	4.4 ±0.2^b
175	2.5 ± 0.2^a	5.1 ±0.3^b
225	2.2 ± 0.4^a	4.8 ±0.8^b
	b*	
125	39.3 ± 1.4^a	34.3 ± 0.5^b
175	38.6 ± 0.3^a	35.8 ± 0.7^b
225	39.6 ± 1.4^a	35.8 ± 0.7^b

SEI results are means ± SD (n= 10) and L*, a*, b* results are means ± SD (n= 5) p<0.05; values of the same row, followed by the same letter (a, b) are not statistically different (p<0.05).

Table 2: Sensory evaluation scores of extrudates with and without tomato pulp (extruded at 145°C, 175 rpm, and 30% moisture).

Parameters	Corn Grit	Tomato Pulp Added
Appearance	6.75 ± 1.36^a	7.08 ± 1.24^a
Taste	5.83 ± 1.47^a	6.67 ± 107^a
Color	6.67 ± 1.37^a	7.25 ± 1.14^a
Porosity	6.50 ± 1.57^a	6.67 ± 1.23^a
Crispiness	4.75 ± 2.09^a	5.67 ± 2.19^a
Overall preferences	6.00 ± 1.54^a	6.58 ± 1.31^a

Results are means ± SD (n= 12), p<0.05; values of the same row, followed by the same letter (a) are not statistically different (p<0.05).

The total phenol content decreased with the extrusion process, whereas shear rate had no significant effect (Table 3a.). The reduction of total phenolic content during extrusion has been cited many times in literature [3]-[6]. Phenolic compounds are affected by the heat treatment and chemical changes can occur. The complex polyphenolic compounds can be broken to other phenolic compounds or non-phenolic compounds [6]. There are some studies citing that total phenolic content did not change during extrusion [7] and [8]. The antioxidant activity was not affected by extrusion and shear rate had no significant effect during extrusion at selected conditions (Table 3b). Sensoy *et al* [8] stated that the antioxidant activity was not affected by the extrusion process but the roasting decreased the antioxidant activity. Several other researchers stated a decrease in antioxidant activity during extrusion [4] and [7]. In our study, despite the high temperature, non-changing characteristic of antioxidant activity could be from the short process time in the extrusion. The differences in the literature could be due to sample, processing and analysis differences in all the studies. It is important to determine the effect of processing on functional compounds so that processing time and temperature can be optimized to keep functionality of active compounds.

Table 3: a. Total phenol content, b. antioxidant activity of the feed and the products extruded at 160 ℃ last zone temperature, screw speeds of 125 and 225 rpm.

a.

	GAE mg/ g dry sample
Feed	12.41 ± 0.76 [a]
125 rpm	3.39 ± 0.47 [b]
225 rpm	2.59 ± 1.33 [b]

b**.**

	TE µmol/ g dry sample
Feed	15.50 ± 3.02 [a]
125 rpm	15.16 ± 3.60 [a]
225 rpm	14.72 ± 3.34 [a]

Results are means ± SD (n= 3); values of the same column, followed by the different letter (a,b) are statistically different ($p<0.05$).

4. Conclusions

Addition of tomato pulp to corn grit at the selected ratio increased the sectional expansion index at two screw speeds. Redness slightly was higher and yellowness decreased for pulp added samples. Sensory evaluations were complimentary stating not a significant difference between the pulp added and not added samples. Extrusion process caused decrease in total phenol content but no change in antioxidant activity. Effect of shear rate was not significant for either total phenolic or antioxidant activity.

5. Acknowledgements

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