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Production and development of tomato crisps from tomato pomace

Natcharee Jirukkakul[1, *]

[1] School of Agro-Industry, Faculty of Applied Science and Engineering, Khon Kaen University, Nong Khai Campus, Nong Khai, Thailand, 43000
*Corresponding author: pnatch@kku.ac.th

Abstract

The production of a crispy snack made from tomato pomace is not only a way to increase nutrition, but it can also increase the value of the byproducts from the tomato industry. Therefore, the objectives of this research were to produce three flavors of tomato crisp: spicy, original, and sesame (to be used in cereals). Tomato pomace obtained from two tomato sauce factories in Nong Khai, Thailand, was used to prepare the crisps. We found that spicy tomato crisps had a higher level of consumer acceptance than the original or sesame flavors. The source of the tomato pomace did not differ significantly among the different treatments. The chemical composition of the tomato crisps with the highest acceptance was 8.58, 4.36, 2.14, 12.72, and 46.48 % for protein, fat, fiber, ash, and carbohydrates, respectively. The lightness, red color, and yellow color were 51.55, 13.68 and 27.50, respectively. The brittleness and crispiness of that sample were 1.248 mm and 13.03 N/mm, respectively.

Keywords: Tomato, Pomace, Crisps

1. Introduction

In addition to tomatoes (*Lycopersicon enculentum* Mill) being one of the most popular vegetables, they also contain lycopene, which is an antioxidant. In addition, they are a rich source of potassium, which plays an important role in transmitting nerve signals and maintaining the balance of fluids in the body. They are also rich in vitamins and minerals [1].

In 2002, there were 65,000 Rai dedicated to growing tomatoes in Thailand [2]. Tomatoes are consumed both fresh and as processed products, with 22% of the total amount of tomatoes harvested being varieties that are consumed fresh [3]. Tomatoes can be eaten in salads, on sandwiches or can be consumed as sauce. There are 1.92 billion tons of tomatoes harvested for use by factories as processed products per year [3]. Industries that produce tomato sauce and tomato concentrate generate a byproduct known as tomato pomace consisting of peels and seeds, which decay easily. Tomato pomace comprises 10-15% of the tomato volume or about 0.19 - 0.29 billion Tons per year [2]. It can be used for animal feed or for human consumption, as tomatoes contain high levels of fiber and pectin. Moreover, the tomato skins are a good source of lycopene, which is an active ingredient with important health benefits. In addition, lycopene can combat oxidative damage. Tomato pomace has also been found to reduce cholesterol levels in the liver by 15% and in the heart by 18% [4].

Tomato pomace is also used in animal feed, such as that of sheep [5] and rabbits [6], in which tomato pomace (10%) has been used as a substitute for rice straw and rice bran. The tomato seeds that are generated have been used as a substitute for maize oil in hamster feed in order to reduce cholesterol levels in the animals [7].

Tomato pomace is also used in food consumed by humans. Good examples include beef frankfurters, beef sausages, and meat-free sausages, which contain 7% tomato pomace [8]. There are also snack foods made from barley-tomato pomace which consists of 2-10% pomace [9].

In today's marketplace, most snacks have a higher sodium content than the standard requirements. Organizations have organized campaigns aimed at decreasing snack consumption and supporting the production of snacks that are highly enriched. Thus, the creation of healthier snacks has been of great concern. Researchers have studied the nutritional value of ingredients used in snack foods, such as cauliflower [10], a blend of barley

and grape pomace [11], and pineapple pomace [12]. Despite tomato pomace having a high nutritional value, it has not been used in the production of snack foods. The aim of this study was to study the production and development of a type of crisps from tomato pomace.

2. Materials and Methods

2.1. Materials

Fresh tomato pomace was provided from two tomato sauce factories (A and B) in Nong Khai province in Thailand. Tomato sauce is produced in these factories for only three months each year (approximately January-March). The tomato pomace was kept at -18°C until it could be used in the experiments. The ingredients were purchased from local markets in Nong Khai Province.

2.2. The Production of the Tomato Crisps

The frozen tomato pomace was thawed at room temperature (25-30°C). It was washed using 0.3% brine and drained. The tomato pomace (1 kg) was mixed with 50 g light soy sauce, 5 g sweet soy sauce, 100 g water, 100 g sugar, 2 g pepper, 4 g salt, and 0.3% corn starch solution as the binding materials. The mixture was pressed into a thin sheet (1 mm) with a roller and dried in the oven at 60°C for 8 h. After that, it was cut in small pieces (10 x 15 cm), and the tomato crisps were obtained. They exhibited the red-orange color of tomatoes as well as a distinct tomato aroma. Finally, they were stored in polyethylene zip bags until testing.

The spicy formula was obtained by sprinkling seasoning powder on top of the dried tomato sheet before it was cut into pieces. The sesame formula was obtained by substituting the 30% of tomato pomace with 30% white sesame when the ingredients were being mixed. After that step, the mixed ingredients were treated using the same method as was used in the original formula. The tomato pomace and tomato crisps are shown in Figure 1.

2.3. Proximate Analysis

The protein, fat, ash, crude fiber carbohydrates, and moisture content of the tomato pomace and tomato crisps were tested following the AOAC [13] standard method. All values were determined over three replications.

2.4. Texture Analysis

A texture analyzer (Micro Stable Systems, Godalming, UK) was used to determine the crispiness and brittleness of the tomato pomace. The samples were cut into pieces of 2.5 x 2.5 cm^2 and were placed on the base mouth of a 1.5 cm-diameter cylinder. A cylinder probe and the ball probe were then used to test for crispiness and brittleness, respectively. The probe speed was 1 mm/s, and 5 replications were performed.

Figure 1 Tomato pomace (a) Tomato crisp (b) Spicy tomato crisp (c) and Sesame tomato crisp (d)

Table 1 The proximate analysis of tomato pomace and tomato crisps

Composition (dry basis)	Protein	Fat	Ash	Fiber	Carbohydrates
Tomato pomace A	8.33±0.12^{b}	13.93±0.14^{a}	3.30±0.08^{f}	40.48±4.80^{bc}	33.96
Tomato pomace B	8.66±0.18^{b}	10.26±0.10^{b}	2.70±0.85^{f}	49.66±1.00a	28.72
Tomato crisp A	8.75±0.74^{b}	5.02±0.09^{d}	5.56±0.08^{d}	35.58±0.41d	45.09
Tomato crisp B	9.28±0.22^{b}	1.50±0.05^{f}	7.80±0.21^{b}	44.07±0.50b	37.36
Spicy tomato crisp A	8.58±0.24^{b}	4.36±0.81^{de}	12.72±0.01^{a}	27.86±1.10f	46.48
Spicy tomato crisp B	8.76±0.21^{b}	3.73±0.06^{e}	12.43±1.25^{a}	40.05±2.35c	37.36
Sesame tomato crisp A	14.29±1.00^{a}	10.82±0.45^{b}	4.75±0.02^{e}	30.76±1.07e	39.38
Sesame tomato crisp B	15.49±0.12^{a}	8.01±0.66^{c}	6.06±0.07^{c}	38.15±0.44c	46.99

Different letters in the same column indicates the statistically significant difference ($p < 0.05$)

2.5. Color Measurement

The color of the tomato crisps was evaluated with a Chroma meter (Color meter, JS555, China) using L*a*b* coordinates. Five positions were used to determine the color for each sample.

2.6. Sensory Evaluation

The tomato pomace was served to 30 trained panelists who were also habitual consumers of snacks. The panelists rated it using a nine-point hedonic scale sensory test sheet. A score of 1 represented “extremely disliked” and a score of 9 represented “like very much”. The panelists checked the requirements to evaluate the quality of the product in terms of color, aroma, flavor, texture, appearance, and the overall acceptability of the tested samples.

3. Results and Discussion

The tomatoes that were used as raw material in factories A and B were of the same cultivar. This cultivar is generally used in the processing of tomato sauce. Thus, differences in the pomace from the two factories was due to differences in processing methods such as smashing, pulping, and pomace separation. Moreover, the pomace was affected by post-processing conditions. High temperatures caused a fermented odor and dark color. The pomace from factory B was darker than that from factory A, meaning that the pomace from factory A was fresher that from factory B. The quality of the resulting product, thus, depended on the quality of raw materials.

3.1. Proximate Analysis of the Tomato Pomace and Tomato Crisps

The chemical composition of the tomato pomace (11.9-15.5% moisture content) showed that it is a high source of fiber and protein (Table 1). The amount of fiber was similar to that of the pomace used in a study by Savadkoohi et al. [8], who experimented with the addition of tomato pomace to meat products. The sesame tomato crisps had a high protein and fat content, whereas the original tomato crisps and the spicy tomato crisps exhibited no significant difference in terms of either of these values. The spicy tomato crisps contained a flavoring powder which had the effect of increasing ash content. The product that was obtained exhibited a higher fiber and protein content, and was lower in fat when compared with commonly consumed snacks, such as apple snack bars, containing 1.07-3.66% protein and 8.48-9.97% lipids [14].

3.2. Textural Analysis of Tomato Crisps

There was no significant difference in terms of brittleness or crispiness among the various treatments. With regard to crispiness and brittleness, the obtained crisps were similar to those of extruded barley-grape pomace, at 4.27-19.62 N/mm and 0.69-1.06 mm for crispiness and brittleness, respectively. The results were similar to those found using extruded pineapple pomace [12].

3.3. The Color of the Tomato Crisps

The color of the tomato crisps was red or red-orange, similar to the color of the tomatoes used. The red color of the obtained crisp was similar to that of extruded barley-tomatoes, which have been shown to have an a* value of 15.41 [9]. The red color was the brightest in the spicy tomato crisp due to the addition of red spice powder, and the original tomato crisps exhibited the highest lightness. There was no significant difference in terms of yellowness (Table 2).

Table 2 The crispiness, brittleness and color of the tomato crisps

samples	Crispiness (N/mm)	Brittleness (mm)	L*	a*	b*
Tomato crisp A	10.32±2.84	1.267±0.08	58.08±1.18^{a}	9.37±2.30^{d}	27.53±3.37^{c}
Tomato crisp B	na	na	50.00±0.66^{b}	15.02±0.21^{c}	34.97±0.59^{ab}
Spicy tomato crisp A	13.03±3.52	1.248±0.07	51.55±2.55^{b}	13.68±1.16^{cd}	27.50±1.56^{c}
Spicy tomato crisp B	na	na	49.01±0.89^{b}	18.58±0.46^{a}	35.82±1.34^{a}
Sesame tomato crisp A	7.18±2.65	1.373±0.06	54.92±5.30^{b}	10.67±2.54^{d}	26.11±3.37^{c}
Sesame tomato crisp B	na	na	49.54±0.28^{b}	16.63±0.41^{b}	32.10±1.24^{b}

Different letters in the same column indicates the significant difference ($p < 0.05$)

Table 3 Sensory evaluation of tomato crisps using nine-point hedonic scale (n=30)

Characteristics	Tomato crisp A	Tomato crisp B	Spicy tomato crisp A	Spicy tomato crisp B	Sesame tomato crisp A	Sesame tomato crisp B
Appearance	5.17±2.00^{b}	5.00±1.76^{b}	6.17±1.64^{a}	5.43±1.61^{a}	5.13±1.74^{b}	5.07±1.57^{b}
Color	5.20±2.01^{ab}	5.03±1.75^{ab}	6.10±1.79^{a}	5.53±2.05^{a}	5.03±1.83 ^{ab}	4.37±2.16^{b}
Odor	4.30±2.22^{a}	4.40±1.77^{a}	4.40±2.22^{a}	4.83±2.09^{a}	4.20±1.79^{a}	4.40±2.03^{a}
Flavor	4.83±2.12^{ab}	3.93±1.95^{b}	5.50±2.06^{a}	5.67±1.81^{a}	4.33±2.06^{b}	4.03±2.13^{b}
Texture	5.13±1.98^{a}	4.67±1.66^{a}	5.37±2.06^{a}	5.20±1.83^{a}	4.67±1.67^{a}	4.47±2.06^{a}
Overall	5.13±1.77^{ab}	4.67±1.73^{b}	6.00±1.91^{a}	5.393±1.89^{a}	5.10±1.69^{ab}	4.90±2.12^{b}

Different letters in the same raw indicates the statistically significant difference ($p < 0.05$)

3.4. Sensory Evaluation of the Tomato Crisps

The preferences of the consumers toward the tested crisps are shown in Table 3. Scores differed among the various formulas. The crisps made from the pomace from factory A were rated as “liked a little” (score 5-6). The spicy tomato crisps were found to be the most preferable of the three formulas in terms of all of the customer preference characteristics that were evaluated. The results indicated the spicy flavor was important for the snacks to be accepted by customers. Within the same formula, there were no significant differences between the tomato pomace obtained from factory A and that obtained from factory B with respect to any of the characteristics evaluated.

4. Conclusion

Tomato pomace, which is a byproduct of tomato processing, can be used to produce crisps. The crisps made from pomace from factory A were more acceptable than those made from that from factory B because of the relative freshness of the former. However, there was no significant difference in terms of acceptance of products by testers. The preference test showed that the spicy tomato crisps were the most acceptable. The tomato crisps that were obtained had a low fat and high fiber content, which makes them a healthy new food product. Moreover, the production of this snack could increase in the value of the byproducts of the tomato industry.

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