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Sensorial Assessment of Different Mitigation Strategies of Acrylamide in Potato Chips

Mahwash Aziz, Iqra Azam and Aiza Zafar

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Sensorial assessment of different mitigation strategies of acrylamide in potato chips

Dr. Mahwash Aziz[1], Iqra Azam[2], Aiza Zafar[3]

[1]Assistant Professor, Department of Food Science and Technology, GCWUF

[2]Research Assistant, Department of Food Science and Technology, GCWUF

[3]Research Assistant, Department of Food Science and Technology, GCWUF

ABSTRACT

Acrylamide (AA) is a carcinogen compound found in many foods consumed in diets globally. It is formed basically from the reaction of reducing sugars (e.g., glucose or fructose) with amino acid asparagine via the Maillard reaction, which take place during heat processing of foods, mainly those derived from plant origin, such as potato and cereal products, above 120℃. The International Agency for Cancer Research (IARC) classifies acrylamide as "probably a human carcinogen" based on animal studies. It is a potential human cancer-causing agent, genotoxicant and a known human neurotoxicant. However, efforts to lessen the development of AA in food have caused in some success. The aim of the current work was to evaluate the effect of different mitigation strategies of acrylamide on sensory properties of potato chips through 9 point hedonic scale. Mitigation strategies include reduction of temperature during frying, addition of organic acid (e.g., citric acid) and use of rosemary extract. Acrylamide formation increased dramatically with increase in frying temperature. Minimum amount of acrylamide formed at temperature of 160°C. Frying at temperature 160°C does not affect the sensory properties of chips. Dipping of potato chips in solution of citric acid at concentration of 1% significantly reduce acrylamide. It does not have any effect on crispiness and flavor of potato fries. Rosemary extract used in the range of 2%, it reduce acrylamide but has effect on sensory properties of potato chips and reduce the firmness of chips. From the results it can be concluded that decreasing temperature, use of rosemary extract and citric acid reduce acrylamide but use of 1% citric acid gives best sensory results.

Keywords: Acrylamide; carcinogen; citric acid; rosemary extract; genotoxicant; neurotoxicant; mitigation; citric acid; sensory; temperature

1. INTRODUCTION

Fried foods are those foods which have a satisfying taste, crispy texture, inexpensive, create satiety and can be easily developed [1]. However fried foods have many adverse effects on health. FAO and WHO indicate that consumption of these foods other than beyond limits implicates many risk effects for health, because eating of fried foods are linked with many diseases such as heart disease, diabetes, cancer and stroke [2]. This fact is mainly due to the high energy density and content of toxic compounds such as unsaturated fatty acids, which can lead to growth retardation in children and hepatotoxicity [3]. Another toxic compound formed during the frying process is acrylamide, which is classified as potentially carcinogenic in humans by the International Agency for Research on Cancer. Food contact with acrylamide is associated with an increase in some types of cancer, which is why the occurrence of this compound in foods is a public health issue [4].

Potato stocks are effectively in danger to acrylamide development because of their asparagine and reducing sugars substance, just as the conventional applied cooking circumstances (temperatures >120ºC), like broiling and simmering. Because of the huge intake of singed potato groceries globaly, the decrease of undesirable AA, without bargaining the tangible attributes is essential [5] .French fries are accomplished by a searing interaction, which contains a complete preparing of the food in a greasy medium (oil), at a temperature fluctuating somewhere in the range of 160 and 200°C. During the searing practice, a few synthetic and actual responses occur. These responses adjust the organoleptic attributes of the food, giving the item a specific surface and sensorial angle and being responsible for the potato nibble is in the pinnacle class utilization overall [6].

The significant methodologies proposed to lessen AA in potato items are the determination of cultivar and capacity conditions, the control of time and temperature of warmth treatment, the use of various browning strategies (for example under vacuum), the utilization of asparaginase compound and boiling water whitening as pre-treatments [7]. However, these approaches show various drawbacks, for example, long regulation occasions, significant expenses, terrible tangible changes and troublesome execution. The aim of the present work was to evaluate the effect of different mitigation strategies of acrylamide on sensory properties of potato chips by using 9 point hedonic scale because these mitigation strategies may affect the sensory properties of potato chips. Mitigation strategies includes reduction of temperature during frying, addition of organic acid (e.g., citric acid) and use of rosemary extract.

2. MATERIALS AND METHODS

Potatoes (*Solanum tuberosum* L.) and frying oil was procured from market. Tubers were wash away in running water, physically peeled and cut in portions of 1.5 ± 0.2 mm thickness by using a cutter. Potato slices were washed instantly after cutting for nearly 1 min in tap water (18 ± 2°C) in order to exclude part of the starch material from the surface.

2.1. Pre-treatments

Pre-treatments of French fries was done that includes reduction of temperature during frying, addition of organic acid (e.g., citric acid) and use of rosemary extract.

2.1.1. Treatment with citric acid

Potato slices were soaked in 1% citric acid solution. After that, all samples were deep-fried at 160℃. All trials were run in triplicate. Fried slices were drained after frying over a wire screen for 5 min and allowed to cool to room temperature before sensory analysis.

2.1.2. Treatment with rosemary extract

The rosemary extract was added at a concentration of 2% and then fried. All experiments were run in triplicate as mentioned above.

2.1.3. Frying Conditions

The rinsed slices were deep-fried at reduced temperature to about 160℃ instead of 180℃ with different frying times. All experiments were run in triplicate as mentioned above.

2.2. Sensory evaluation of potato chips

Sensory evaluation of each treatment was done separately. Potatoes chips samples was labeled according to the treatment prior to sensory test. Sensory evaluation of potato chips samples were done using 9 point hedonic scale. Judges was asked to score strips for taste, texture, crispiness, color, odor and overall acceptability.

2.3. Statistical Analysis

At the end, data was statistically analyzed and means were calculated.

3. RESULTS AND DISCUSSION

Sensory evaluation is a fundamental characteristic originally performed for quality and excellence evaluation in order to acquire the perspective of the panelists about a developed product. It also acts as a tool for assessing the acceptability of customer.

3.1. Color

Color is a vital factor for assessing the effects of different treatments on the reduction of acrylamide and acceptance of product, but also convey information about product development and quality. It is one of the necessary trait for consumer to accept product. The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for color of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 6.98 ± 0.01^{a}, 4.65 ± 0.93^{c} and 5.98 ± 0.01^{b}, respectively. The highest value of color was observed in T_1 potato chips treated with 1% citric acid 6.98 ± 0.01^{a} and lowest value 4.65 ± 0.93^{c} was observed in T_2.

Regarding to color, it could be noticed that, the highest values of color were recorded for citric acid treatments (1%) comparing to others. These results are in agreement with those reported by Amany and Shaker [8] ,who found that, fried potato slices was characterized by an appropriate golden-yellow color, pretreated by immersion in acid solution

(citric acid 1%), than other treatments which led to produce fried potato with slightly darker color. These findings was also agreed with those of Jung *et al.* [9], who found while increasing the concentration of citric acid, it reduce acrylamide but contrary it decrease the sensory quality of potato chips because sensory quality of French fries worsened when the added citric acid reached the level of 2% (w/w).

The appearance in color conferred lower values for T_2 potato chips treated with rosemary extract (2%) with regard to the other samples. It should flow from to an occasional uniformity in color and irregularity within the kind was determined. This result was conjointly rumored by Mousa [10], who found that the potatoes had a unique look as a result of the upper wetness and more moisture. However, this truth doesn't indicate a scarcity of acceptance by the buyer. The looks of the potato may be a frequent drawback at industrial level, as a result of it depends on the chemical composition of the tuber (reducing sugars). This composition, in turn, depends on several environmental and storage factors, as a result of the reducing sugars verify the standard of the deep-fried potato, providing a darker color and a bitter taste due to participation in non-enzymatic browning reactions.[11]

Frying at higher temperature ends up in darker the color of chips. Many studies have shown that in sauteing, underneath part or vacuum conditions, higher temperatures increase the extent of browning, supporting the results determined during this work. The high level of sauteing temperature raised the most force needed to break the chips, as well as their hardness and crispness also increases. These results square measure in agreement with those reported by other researchers for vacuum sauteing. [12]

3.2. Taste

Taste is a key for product's liking or disliking. Taste refers to the perception of the sensory cells in your taste buds. When food compounds activate these sensory cells, your brain detects a taste, like sweetness. The perception of taste combines sense of flavor and smell with texture affected by appearance. The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for taste of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 6.98 ± 0.01^a, 3.97 ± 0.02^c and 6.95 ± 0.04^b. The highest value of taste was observed in T_1 potato chips treated with 1% citric acid 6.98 ± 0.01^a and lowest value 3.97 ± 0.02^c was observed in T_2.

These findings agreed with Abou-Zaid [13], who reported that potatoes treated with citric acid treatments (0.5%, 1% and 2%) and their taste values were 7.38, 7.22 and 7.00, respectively.

The results elucidated by Dilmer [14], that coated have a darker color and a bitter taste due to the participation in non-enzymatic browning reactions.

3.3. Texture

Texture is one of the characteristics used by customers to evaluate the food quality. Texture of food particles is an important part of our sense when we feel food in our mouth. It is can be described in relations such as 'hard,' 'liquid,' 'solid,' 'rough,' 'crumbly, 'smooth,' 'creamy,' 'crispy,' 'lumpy,' 'soft,' 'gritty,' etc. Texture is significant in determining the eating excellence of foodstuffs. Texture have a strong effect on food consumption and nourishment.

Apparent texture is narrowly linked to the arrangement and structure of the food, and both microscopic and macroscopic levels of structure can influence texture.

The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for texture of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 6.98 ± 0.01^a, 5.98 ± 0.01^b and 6.98 ± 0.01^a, respectively. The highest value of taste was observed in T_1 potato chips treated with 1% citric acid 6.98 ± 0.01^a and lowest value 5.98 ± 0.01^b was observed in T_2.

Result shows that there was a very clear influence of the frying temperature over finishing texture. Crust development in fried potatoes is the result of fluctuations in the original structure in the potato flesh, such as, softening of the internal lamella between cells, starch gelatinization and dehydration, being the gelatinization of starch during heating the major influence over the surface of potato chips [15].

3.4. Crispiness

Crispiness is one of commonest food texture traits. Crispiness refers to a hard food that produces a sound upon breaking. Foods defined as crispy tend not to show symbols of bend prior to break. Crispiness and crunchiness are often used interchangeably, however crispiness tends to be related with a higher pitched sound, while crunchiness is related with lesser leaning sounds.

The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for crispiness of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 6.98 ± 0.01^a, 4.97 ± 0.01^c and 5.98 ± 0.01^b. The highest value of taste was observed in T_1 potato chips treated with 1% citric acid 6.98 ± 0.01^a and lowest value 4.97 ± 0.01^c was observed in T_2.

These results are agreed with the Abou-Zaid [13], who reported that potatoes treated with citric acid treatments (0.5%, 1% and 2%) showed that all studied treatments improved the crispiness state of fried potato chips. The great level of frying temperature enlarged the maximum force necessary to break the chips, as well as their firmness and crispness [15]. Chips fried at altered frying temperatures showed important difference in break force. Chips fried at 120°C showed the lower fracture force, while those fried at 180°C showed higher fracture force. Break force has been reported to be improved with increase in frying temperatures and duration due to the progressive increase and toughening of the crust of the chip [16].

3.5. Odor

Odor is produced by one or other volatilized chemical compounds that are usually found in low concentrations that humans and animals can distinguish by their brains. An odor is also called a "smell" or a "scent", which can denote to either a pleasurable or an unpleasant odor.

The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for odor of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 5.98 ± 0.01^a, 4.98 ± 0.01^b and 4.98 ± 0.01^b. The highest value of taste was observed in T_1 potato chips treated with 1% citric acid 5.98 ± 0.01^a and lowest value 4.98 ± 0.01^b was observed in T_2 and T_3.

These findings of odor agreed with Abou-Zaid [13], who reported that potato treated with citric acid treatments (0.5%, 1% and 2%) all studied treatments had a positive effect on improving the product odor.

The existing consequence of odor were in harmony with the conclusion of Agudelo *et al.* [17], who applied rosemary and whey protein in different concentration. According to this, the coated potato presented higher qualification in the oily, sweet, and toasted odor attributes, which is well perceived by the consumer.

3.6. Overall acceptability

The overall acceptability is a vital factor for assessing the manufacturing of potato chips to reduce acrylamide after applying different treatments. It is one of the necessary trait for consumers to accept product. The overall acceptability is a fundamental characteristics originally performed for quality and excellence evaluation in order to acquire the perspective of the panelists about a developed product. It also acts as a tool for assessing the acceptability of customer. The results elucidated that by applying different treatments included addition of citric acid, use of rosemary extract and reduction of temperature during frying show significant effects ($P \leq 0.01$) as given in table 1.

The mean presented in table 1 for taste of potato chips with different treatments T_1, T_2 and T_3 (addition of citric acid, use of rosemary extract and reduction of temperature during frying) showed that values were 7.98 ± 0.01^a, 5.98 ± 0.01^c and 6.98 ± 0.01^b. The highest value of taste was observed in T_1 potato chips treated with 1% citric acid 7.98 ± 0.01^a and lowest value 5.98 ± 0.01^c was observed in T_2.

Table: 1 Effect of different mitigation treatments on sensory properties of potato chips

Treatments	Color	Taste	Texture	Crispiness	Odor	Overall acceptability
Citric acid (T_1)	6.98±0.01[a]	6.98±0.01[a]	6.98±0.01[a]	6.98±0.01[a]	5.98±0.01[a]	7.98±0.01[a]
Rosemary extract (T_2)	4.65±0.93[c]	3.97±0.02[c]	5.98±0.01[b]	4.97±0.01[c]	4.98±0.01[b]	5.98±0.01[c]
Frying Conditions (T_3)	5.98±0.01[b]	6.95±0.04[b]	6.98±0.01[a]	5.98±0.01[b]	4.98±0.01[b]	6.98±0.01[b]

4. FOOT NOTES

Dr. Mahwash Aziz dr.mahwashaziz@gcwuf.edu.pk

Iqra Azam iqrabajwab@gmail.com

Aiza Zafar aizazafar@gcwuf.edu.pk

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