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Research Article

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Acrylamide Mitigation of Fried Potato Chips by Using Amino Acids

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ABSTRACT

Potato chips are very popular product especially among younger generations. This could be a potential source of acrylamide, a toxic compound which could develop during frying and baking processes. In the present work, the effect of Amino acids pretreatment, concentration of amino acids, frying conditions with respect to temperature and time on mitigation of acrylamide were studied. Potatoes slices were fried at two different temperature and time combination such as 160^o C for 7 mins and 180^{o}C for 4 mins by using refined peanut oil. Prior to frying, potato slices were rinsed with distilled water plus blanched in hot water at 100^o C for 2 mins plus immersed in 0.5 and 1.0 per cent of glycine as well as cysteine for 1 h. The potato slices without soaking in any solution served as control. The highest decrease was observed for those potato slices immersed in 1.0 per cent of cysteine and fried at 160^{o}C for 7 mins. The result of the study indicates that the addition of certain amino acids is an effective way of reducing acrylamide in fried potato chips.

Keywords: *Acrylamide, Potato chips, Glycine, Cysteine,*

INTRODUCTION

Potato (*Solanum tuberosum* L.) popularly known as 'The king of vegetables', has emerged as fourth most important food crop in India after rice, wheat and maize. Indian vegetable basket is incomplete without Potato and it is consumed daily by millions of people from diverse cultural backgrounds. In India, potatoes have been utilized largely for consumption as fresh potatoes and the major part of potato harvest (approx. 68.5%) goes to domestic table consumption. Whereas, in the developed countries, table potato utilization is merely 31 per cent, rest being frozen french fries (30%), chips and shoestrings (12%) and dehydrated products (12%) (Singh et al., 2016).

Chips and snacks have become part of the daily diet for rural and urban in India. Acrylamide has been found to occur in many fried starchy foods especially potato chips and french fries.

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Acrylamide is a chemical compound that is formed from food components during high temperature heat treatment (frying, baking, roasting and grilling) as a result of the maillard reaction between reducing sugars (glucose and fructose) and amino acids (asparagine).

The mechanism of acrylamide formation is, during heat treatments, the amino group of a free asparagine reacts with the carbonyl group of sugars to make a Schiff base. Later, the base can be hydrolysed to yield a 3-aminopropionamid, which is then converted to acrylamide by elimination of the ammonia molecule.

It is of great concern in recent days as it is known to be a possible carcinogen. It was discovered in foods during the year 2002 by Swedish National Food Agency (SNFA). Acrylamide formation in foods was influenced by several factors, including processing temperature, time, content and species of reducing sugars and amino acids, pH, moisture content and frying oils, etc (Pedreschi et al., 2005). Many of the studies have been conducted to develop possible mitigation strategies to limit acrylamide levels in various foods, especially fried potato products (Granda & Moreira, 2005, Gokmen & Senyuva, 2007). The mitigation strategies include lowering reducing sugars and free asparagine in the raw materials by changing processing methods. Therefore, the main objective of this investigation was to study the effect of different pre-frying treatments on reduction of acrylamide formation of fried potato chips.

MATERIALS AND METHODS

Raw materials and Chemicals

Potatoes of Kufri Jyoti, a processed variety was purchased from CPRI (Central Potato Research Station), Ooty, Tamil Nadu. Refined peanut oil was purchased from the local market. Glysine (FG), Cysteine (FG), Acrylamide (standard), HPLC-grade methanol, HPLC-grade acetonitrile, HPLC grade hexane and HPLC deionised Milli-Q water were purchased from M /s Sigma Aldrich, Bangalore.

Preparation of potato slices

The potatoes were washed with tap water and peeled manually. Further, it was cut into slices of approximately 1.0 mm thickness using vegetable slicer. Slices were washed with distilled water immediately after cutting to remove some starch found at surface of the slices. Then the slices were subsequently blanched by heating potato slices in hot distilled water at 100^{o}C for 1 min. The potato slices-to-water ratio was 1:5 w/v was used for blanching.

Pre-treatments

Blanched slices were soaked for 1 h in distilled water containing of 0.5 and 1.0 per cent of amino acids such as Glycine and Cysteine. The potato slices to amino acid solution ratio was 1:10 w/v *i.e* 100 g of potato slices were soaked in 1 L of water.

Frying conditions

Potato slices were deep-fried in hot refined peanut oil contained in electrical fryer (American Micronic Instruments, India) at two different temperature and time combination *i.e* 160^{o}C for 7 mins and 180^{o}C for 4 mins. Frying temperature was kept almost constant (±1^{o}C). The potato slices and oil ratio was 1:10 (w/v)

Acrylamide analysis

Preparation of standard solutions

The acrylamide analysis was carried out by using HPLC done by method given by Meghavarnam and Janakiraman (2018). Acrylamide standard stock solution (1 mg /mL) were prepared by dissolving 10 mg of the acrylamide in 10 mL of MilliQ water and it was protected from light and stored in a refrigerator at 4^{o}C. All working solutions were prepared freshly by dilution of stock solution in MilliQ water.

Extraction of sample for high performance liquid chromatography (HPLC) analysis

One gram of potato chips were taken and finely ground in a pestle and mortar. The ground potato chips were transferred into a separating funnel and 10 mL of methanol was added. Then it was shaken vigorously for 15 mins. The homogenates was filtered and centrifuged at 10000 g for 10 mins; the centrifuged sample was filtered again through Whatman No.1 filter paper. The homogenate was defatted twice with 10 mL of hexane by allowing the homogenate to stand in water

bath at 30°C for 30 mins. The obtained extracts were filtered through 0.2 µm a nylon syringe filter, which was used for analysis.

The quantification of acrylamide in potato chips was performed using HPLC system (Shimadzu LC10ATVP series) equipped with a C18 column and diode array detector set at isocratic conditions with 97 per cent acetonitrile and 3 per cent 5mM trifluoroaceticacid as mobile phase at 1 mL/ min flow rate and detection carried out at 210 nm at 28°C. Peak areas of the standards were used to interpolate acrylamide concentrations in the samples (Fig. 1). All analyses were performed in triplicates and the average results are expressed as micrograms per kilogram sample.

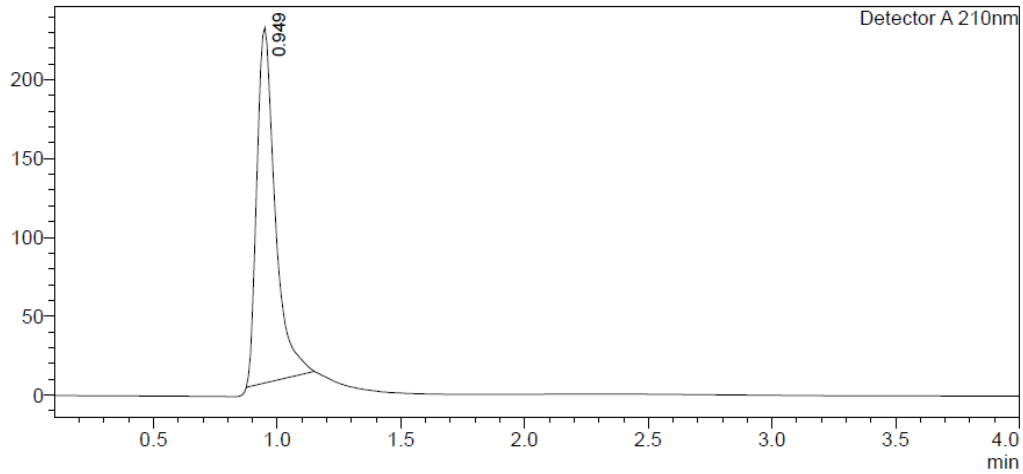

Fig. 1: HPLC Chromatogram of acrylamide standard (1ppm)

Statistical analysis

All the experiments were carried out in triplicate and statistical analysis was performed using AGRES software for Window version 7.0. The statistical significance of data was tested applying analysis of variance (ANOVA) and the test of mean was compared by least significant difference (LSD); level of significance was 0.05.

RESULTS AND DISCUSSION

Acrylamide content

The reduction rate of acrylamide in fried potato chips depends on frying temperature, time and additive concentration. The effects of glycine and cysteine content (0.5% to 1.0%) and frying temperature and time (160°C for 7 mins & 180°C for 4 mins) on the reduction rates of acrylamide in fried potato chips are shown in Figure 2 & 3.

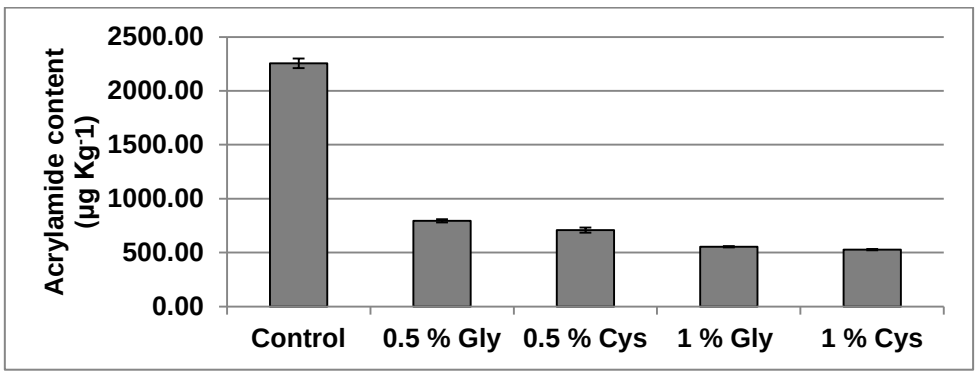

Fig. 2: Effects of amino acids on reduction of acrylamide formation in fried potato chips that were fried at 160°C for 7 min. Cys = Cysteine; Gly = Glycine

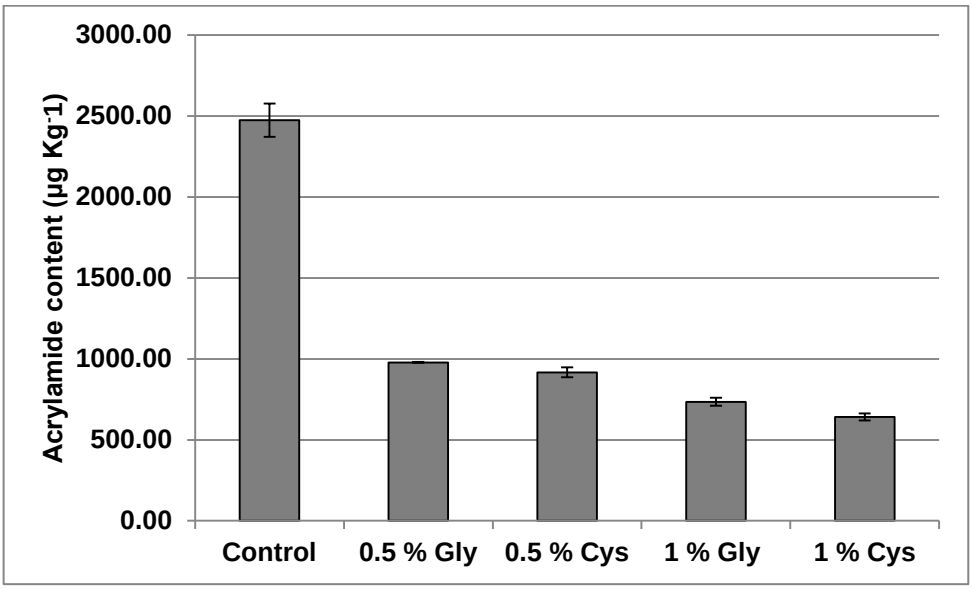

Fig. 3: Effects of amino acids on reduction of acrylamide formation in fried potato chips that were fried at 180°C for 4 min. Cys = Cysteine; Gly = Glycine

Soaking of potato slices in different amino acid solution caused significant reduction in the formation of acrylamide. The average acrylamide contents of fried potato chips soaked in glysine (0.5 & 1.0%) and cysteine (0.5 & 1.0%) that fried at 160^{o}C for 7 mins were 795µgKg^{-1}, 555µgKg^{-1} and 708µgKg^{-1}, 527µgKg^{-1} respectively. Similarly the average acrylamide contents of fried potato chips soaked in glysine (0.5 & 1.0%) and cysteine (0.5 & 1.0%) that fried at 180^{o}C for 4 mins were 978µgKg^{-1}, 735µgKg^{-1} and 917µgKg^{-1}, 642µgKg^{-1} respectively.

The highest decrease of acrylamide content was observed in the potato slices treated with 1.0 per cent of cysteine and fried at 160^{o}C for 7 mins. This may be due to leaching of one important acrylamide precursor glucose. Whereas the potato slices without any pretreatment had least decrease in acrylamide content which is about 2256µgKg-1(160^{o}C for 7 mins) and 2473µgKg-1(180^{o}C for 4 mins) suggesting that amino acid caused significant decreases in acrylamide content of fried potato.

Related study showed that the addition of cysteine or lysine to an asparagine/glucose model system heated between 140 and 200°C significantly lowered acrylamide formation (Claeys et al., 2005). Similarly (Kim et al., 2005) also diminished the acrylamide formation in fried snacks products by adding amino acids, such as lysine, glycine and cysteine. Ismial et al. (2013) studied the effect of different pre-frying treatments on reduction of acrylamide formation of fried potato. The results of their investigation showed that blanching of potato chips in hot water (65 and 85°C) or solutions containing 0.05M citric acid, 0.1 M $CaCl_2$ or NaCl, 0.1M glycine, L-glutamine or L-cysteine reduced significantly acrylamide formation of potato chips by 90.40, 88.88, 90.40, 73.58, 76.91, 85.20 and 76.96 per cent respectively.

Finally the result of the study clearly showed that there is increase in concentration of amino acids lower the concentration of acrylamide. Likewise Frying temperature is important parameter to be monitored, as it directly influences on the formation of acrylamide. Here the concentration of acrylamide increases exponentially with high frying temperature.

CONCLUSION

The potato slices treated with 1.0 per cent of cysteine and fried at 160^{o}C for 7 mins had the highest effect on reduction of acrylamide formation when compared with control. From the investigation, it could be concluded that

the addition of glycine and cysteine at higher concentration (1%) gave significant acrylamide reductions. It is also concluded from the result obtained, that the acrylamide content can be reduced by frying the potato chips at low temperature (160^{o}C). Hence this is an effective, simple, and practical way to limit the acrylamide formation in fried potato chips.

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