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# Use of Microbial Asparaginase to Mitigate Acrylamide Formation in Fried Food

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**Review Article**

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## Abstract

Acrylamide or 2-propenamide is an industrial chemical formed in some foods particularly starchy foods during heating process such as baking, frying and roasting. Acrylamide is present in significant quantities in carbohydrate rich foods such as Potato chips, French fries and Bakery products up to 7000 ppb followed by protein rich foods up to 400 ppb. In general, deep fat fried potato products, roasted coffee beans and bakery products are the most important sources of acrylamide. Acrylamide is proven to be carcinogenic in animals and a probable human carcinogen mainly formed in foods by the reaction of asparagine (free amino acid) with reducing sugars (glucose and fructose) as part of the Maillard reaction during heating under high temperature and low moisture conditions.

The possible strategies of acrylamide reduction were grouped into four categories i.e., selection of raw materials, changing formulation and product composition without affecting the taste and preferences of consumers, pre-treatment procedures and optimized processing conditions. The use of microbial L-asparaginase (LA) is one of the alternative approaches for acrylamide reduction in food stuffs as it catalyzes the conversion of L-asparagine to L-aspartic acid and ammonia.

**Keywords:** Acrylamide; Asparagine; Glycine

## Introduction

Asparaginase, an enzyme is used in food processing industry and also used as a medicine. It is used to treat acute lymphoblastic leukemia, acute myeloid leukemia and non-Hodgkin's lymphoma. In food manufacturing it is used to decrease the acrylamide which is occurred in some starch based foods during baking, frying and roasting. Acrylamide has carcinogenic effect on animals and human. The free amino acid Asparagine reacts with sugars like glucose and fructose during Maillard reaction under high temperature and low moisture condition. To reduce acrylamide in food products bacterial LA (L-asparaginase) is used. Acrylamide has carcinogenic effects on human as well as animals [1]. Recent research work conducted in 2008 on acrylamide has shown different type of human cancer such as human ovarian, endometrial, breast and kidney cancer are linked with high exposure to acrylamide [2, 3]. Acrylamide is linked with Maillard reaction and particularly asparagine in foods [4-8]. Many processes are used to reduce the formation of acrylamide in food stuffs. During baking and frying the formation of acrylamide depend on both moisture content and baking temperature/time. To minimize the formation of acrylamide longer baking times are required if final products are prepared to the same final moisture but with less color development [9, 10]. By substituting (NH4) HCO3 with inverted sugar and raising agents or by spraying with glycine or by adding inorganic salts and organic acids one can reduce the acryl-amide load [11,12]. Alteration of the sensorial properties such as flavor, texture, browning [13] and on the formation of other undesirable compounds [14] may lead to less consumer acceptance. The changes may even affect the technology of the process, for instance, by reducing yeast fermentation properties in bread [15]. Research work shows that asparagine is the major ingredient for the formation of acrylamide in cereal food products. Increased amount of asparagine in various cereal commodities can enhance the production of acrylamide. To reduce acrylamide in different baked and fried products we have to eliminate free asparagine by the enzyme asparaginase, which hydrolyses asparagine to aspartic acid and ammonia. Over 90% of acrylamide content reduced when asparaginase treated mashed potato, potato flakes, rye flour and wheat flour are incubated [8, 11, 16].

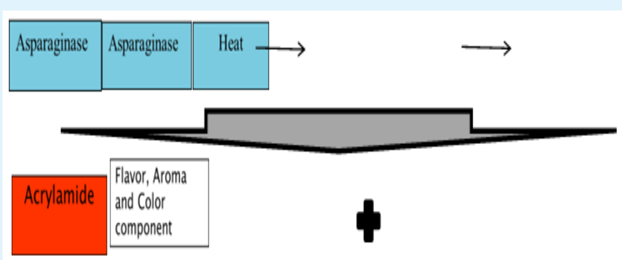


Figure1: Formation of Acrylamide during food processing.

More, et al. [17] made a study with the isolation and optimization of an extracellular L-asparaginase from a fungal microorganism screened from marine soil. Optimization and production of *Trichoderma viride sp.* was performed by submerged fermentation and maximum enzyme production occurred on the third day at pH 6.5 and temperature of 37 °C which showed to be an ideal condition for the marine enzyme. Good scavenging property and the ability to lower the acrylamide levels in food stuffs makes it a valuable enzyme in pharmaceutical and food industries.

Pal et al. [18] reported that Acrylamide is present in significant quantities in carbohydrate rich foods such as potato chips, French fries and bakery products up to 7000 ppb followed by protein rich foods up to 400 ppb. The review summarizes works carried out on the mitigation strategies of acrylamide with respect to deep fat fried foods, microwave heated foods, baked and roasted food products. The possible strategies of acrylamide reduction were grouped into four categories i.e., selection of raw materials, changing formulation and product composition without affecting the taste and preferences of consumers, pre-treatment procedures and optimized processing conditions.

Sanghvi et al. [19] made an investigation on purification of extracellular LA from isolate of *Bacillus subtilissp*. Strain KDPS-1 was by solid state fermentation process. Reduction of acrylamide in fried potatoes was detected by high performance liquid chromatography.

Monomania et al. [20] studied reduction of acrylamide formation in bakery products such as sweet bread by enzyme treatment. LA sparaginase produced from Cladosporium sp. was treated to wheat-based dough at different concentrations (50–300 U). There was no change in the rheological properties of wheat flour and Physico-sensory characteristics of bread with Lasparaginase treatment. Moisture, sugars, L-asparagine, acrylamide, and some indicators of Millard reaction (hydroxymethylfurfural (HMF), color, browning) were estimated. With increase in L-asparaginase level the acrylamide formation was reduced. At 300 U, there was 97 % and 73 % reduction of acrylamide formation in the crust and crumb regions of bread, respectively.

## Mechanism of Action of Asparaginase

Acrylamide is often formed in the cooking of starchy foods. During heating the amino acid asparagine, naturally present in starchy foods, undergoes a process called the Maillard reaction, which is responsible for giving baked or fried foods their brown colour, crust, and toasted flavour. By adding asparaginase before baking or frying the food, asparagine is converted into another common amino acid, aspartic acid, and ammonium. As a result, asparagine cannot take part in the Maillard reaction, and therefore the formation of acrylamide is significantly reduced. Complete acrylamide removal is probably not possible due to other, minor asparagine-independent formation pathways. As a food processing aid, asparaginases can effectively reduce the level of acrylamide up to 90% in a range of starchy foods without changing the taste and appearance of the end product

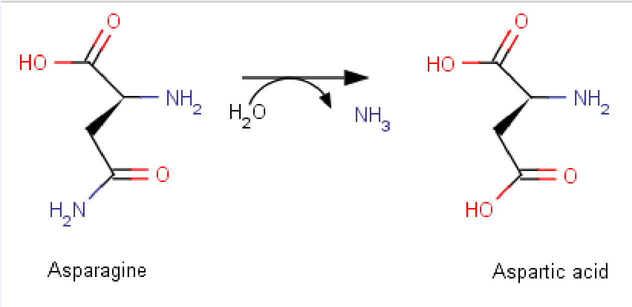


Figure 2: Conversion of Asparagine by the enzyme asparaginase.

## Conclusion

Consumption of heat processed food is very high worldwide. Acrylamide or 2-propenamide an industrial chemical formed in some foods particularly starchy foods during heating process such as baking, frying and roasting. Acrylamide is proven to be carcinogenic in animals and a probable human carcinogen mainly formed in foods by the reaction of asparagine (free amino acid) with reducing sugars (glucose and fructose) as part of the Maillard reaction during heating under high temperature and low moisture conditions. The possible strategies of acrylamide reduction are: selection of raw materials, changing formulation and product composition without affecting the taste and preferences of consumers, pre-treatment procedures and optimized processing conditions. Among which pretreatment with asparaginase enzyme is most effective.

## References

1. Abdel FY, Olama ZAl (2002) Asparaginase production by Pseudomonas aeruginosain solid-state culture: evaluation and optimization of culture conditions using factorial designs. Process Biochem 38: 1665-1668.
2. Adinarayana K, Ellaiah P, Srinivasulu B, Devi RB, Adinarayana G (2003) Response surface methodological approach to optimize the nutritional parameters for neomycin production by Streptomyces marinensisunder solid state fermentation. Process Biochem 38: 1565-1572.
3. Aghaiypour K, Wlodowes A, Lubkowski J (2001) Structural basis for the activity and substrate specificity of Erwiniachrysanthemil-asparaginase. Biochemistry 40(19): 5655-5664.
4. Amrein TM, Schonbachler B, Rohner F, Lukac H, Schneider H, et al. (2004) Potential for acrylamide formation in potatoes: data from the 2003 harvest. Eur Food Res Technol 219(6): 572-578.
5. Basha SN, Rekha R, Komala M, Ruby S (2009) Production of extracellular antileukaemicenzyme l-asparaginase from marine actinomycetes by solid state and submerged Fermentation: purification and characterization. Trop J Pharm Res 8(4): 353-360.
6. Borkotaky B, Bezbaruah (2002) RL Production and properties of asparaginase from a new Erwiniasp. Folia Microbiol 47(5): 473-476.
7. Bradford MM (1976) A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Annals of Biochemistry 72: 248-254.
8. Zyzak DV, Sanders SA, Stojanovic M, Tallmadge DH, Eberhart BL, et al. (2003) Acrylamide formation mechanism in heated foods .J Agric Food Chem 51(16): 4782-4787.
9. Amrein TM, Andres L, Manzardo GG, Amado R (2006) Investigations on the promoting effect of ammonium hydrogen carbonate on the formation of acrylamide in model systems. *J Agric Food Chem* 54: 10253-10261.
10. K Gordon (2006) Review of acrylamide mitigation in biscuits, crackers and crisp bread on behalf of the CAOBISCO acry- lamide research project group, Brussels.
11. TM Amrein, Schonbachler B, Escher F, Amado R (2004) Acrylamide in gingerbread: critical factors for formation and possible ways for reduction. J Agric Food Chem 52(13): 4282-4288.
12. Gokmen V, Enyuva HZS (2007) Acrylamide formation is prevented by divalent cations during the Maillard reaction. Food Chem 103: 196-203.
13. Gokmen V, Acar OC, Koksel H, Acar J (2007) Effects of dough formula and baking conditions on acrylamide and hydroxyl methyl furfural formation in cookies. Food Chem 104: 1136-1142.
14. Gokmen V, enyuva HZS (2007) Effects of some cations on the formation of acrylamide and furfurals in glucose-asparagine model system. Eur Food Res Technol 225(5-6): 815-820.

15. CIAA, Acrylamide Toolbox .Confederation of Food and Drink Industries of the EEC, February 2009, revision 12.

16. Ciesarova Z, Kiss E, Kolek E (2006) Study of factors affecting acrylamide levels in model systems. Czech J Food Sci 24: 133-137.

17. Lincoln L and Sunil SM (2014) Isolation and production of clinical and food grade LA sparaginase enzyme from fungi.JPP 3(3): 177-183.

18. Pal Murugan M, Agathian G, Semwal A D, Sharma GK (2016) A Review on Acrylamide Mitigation Strategies in Various Processed Foods.International Journal of Advanced Research 4(7): 1025-1040.

19. Sanghvi G, Bhimani K, Vaishnav D, Oza T, Dave G, et al. (2016) Kunjadia P and NavinSheth. Mitigation of acrylamide by l-asparaginase from Bacillus subtilisKDPS1 and analysis of degradation products by HPLC and HPTLC. Springer Plus 5: 533.

20. Mohan Kumar NS, Shimray CA, Indrani D, Manonmani HK (2013) Reduction of Acrylamide Formation in Sweet Bread with L-Asparaginase Treatment. Food Bioprocess Technol 7(3): 741-748.