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# Gamma irradiation of alkali extracted protein isolate from dephenolized sunflower meal

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ABSTRACT

The effect of gamma irradiation on physicochemical, antioxidant and functional properties of sunflower protein isolates was investigated. Protein isolates were irradiated at dose level of 0, 10 20, 30, 40 and 50 kGy. Protein solutions obtained from irradiated protein isolates were found more turbid and had higher particle size. Surface hydrophobicity was increased while sulfhydryl content was reduced indicating the conformational changes in protein isolates. Surface hydrophobicity was increased from 122.73 to 139.67 and free sulfhydryl content was decreased from 7.60 to 7.22 μmoL/g and total sulfhydryl content from 78.79 to 52.26 μmoL/g. Available lysine content decreased from 3.30 to 3.21 g/100 g. Lightness of protein isolates was reduced with increase in yellow-brown colour indicating the formation of Maillard reaction products. DPPH radical scavenging of protein isolates was increased from 5.79 to 19.46% and total antioxidant capacity was increased from 7.54 to 27.50%. Solubility, oil binding capacity, emulsion properties and foaming properties were improved, while water binding capacity was impaired. Gamma irradiation treatment can be used to change the conformation of proteins, which could improve their functionality and widen the application area in food systems.



## 1. Introduction

Radiation treatment is a non-thermal process applied to the biological material for reducing the microbial contamination and extending shelf life of food products (Foley, Dufour, Rodriguz, Caporaso, & Prakash, 2002). Gamma irradiation can cause biochemical changes in food products and affects their nutritional and functional properties. Chemical changes in biopolymers, such as proteins, induced by gamma irradiation are subject of considerable study (WHO, 1999). These chemical changes include, fragmentation, aggregation and crosslinking (Davies & Delsignore, 1987; Filali-Mouhim et al., 1997).

Effect of gamma irradiation on proteins may be either direct or indirect. In direct effect, radiations are directly absorbed by protein molecules, which results in alteration in protein molecule. However, in indirect effect, radiation acts first on water molecules and produces active species such as hydroxyl radical and hydrated electrons, that in turn react with the protein molecules and subsequently alter the protein structure (Yamamoto, 1992). The effect of gamma irradiation on proteins causes conformational changes and rupture of covalent bonds (Cheftel, Cuq, & Lorient, 1985). The effect of gamma irradiation on proteins is an irreversible change at molecular level causing breakage of covalent bonds in the polypeptide chains (Lee & Song, 2002). Gamma irradiation of protein can lead to the formation of several reactive intermediate products. These intermediates follow several quick reaction pathways that result in formation of new bonds within the polymer chain, and hence modify the final structure of the polymer (Chmielewski, Haji-Saeid, & Ahmed, 2005).

Sunflower meal contains high amounts of protein ranging from 20 to 50% (Dorrell & Vick, 1997) and higher percentage of proteins are obtained after dehulling of seeds (Malik & Saini, 2017). Sunflower proteins are devoid of any toxic substance and are low in anti-nutritional compounds, which make it an alternative protein source (Gonzalez-Perez & Vereijken, 2007). Except for lysine, the amino acid composition of sunflower proteins complies largely with FAO (Food and Agriculture Organization) pattern (Gassmann, 1983). In spite of having good nutritional properties, these proteins have low functional properties which limit their applications in food systems. Modification using gamma irradiation can be used to alter their structure, which could improve their functional properties. Various proteins have been modified using gamma

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irradiation like porcine and bovine blood plasma proteins (Lee, Lee, & Song, 2003), dry red kidney beans proteins (Dogbevi, Vachon, & Lacroix, 2000) and cow pea proteins (Abu, Muller, Duodu, & Minnaar, 2006) with intent to improve their functional properties. Gamma irradiation affects the physicochemical and functional properties due to alteration in protein structure like increase in molecular weight due to aggregation and crosslinking. The present work was carried out with the aim to modify the sunflower protein isolate with gamma irradiation to improve their functional properties which could enable the targeted and more specific use of sunflower protein isolates in food industry.

## 2. Materials and methods

### 2.1. Materials

The sunflower seeds (variety PSH-996) were collected from the Punjab Agricultural University, Ludhiana, Punjab, India. 5, 5-dithiobis (2-nitrobenzoic acid) (DTNB), 1-anilino-8-naphathalenesulfonate (ANS), Trinitrobenzenesulfonic acid (TNBS) and 2,2-Diphenyl-1-picrylhydrazyl (DPPH) were purchased from Sigma Chemical Co., St. Louis, MO, USA. Tris buffer was purchased from Himedia (Himedia Laboratories Pvt. Ltd. Mumbai, India). Glycine and $Na_2HCO_3$ were purchased from Merck (E-Merck, Mumbai, India). All other chemicals were of analytical grade and were purchased from Rankem (Gurugram, India).

### 2.2. Preparation of meal

The method adopted by Malik and Saini (2017) was used for preparation of meal. Seeds were first dehulled using dehuller (New Twin Roller Huller, Cottor Plants India Pvt. Ltd) and then mechanically pressed using oil expeller (Goyum 20) to obtain the meal. Meal was defatted using hexane by soxhlet extraction for 8 h. The defatted meal was dephenolized by dispersing in methanol (60 mL/100 mL) at ratio of 1:20 (g/mL) for 2 h with continuous stirring. The suspension was filtered and process was repeated four times. The defatted dephenolized meal was then stored for further analysis.

### 2.3. Preparation of protein isolates

Protein isolates were prepared from prepared meal using the method adopted by Malik, Sharma, and Saini (2016). The meal was dispersed in distilled water at meal to solvent ratio of 1:10 (g/mL), stirred for 1 h at temperature of 45 °C and 10.5 pH. The supernatant was collected after centrifugation (10, 000 *g* for 25 min) and was adjusted to pH 4.5 and allowed to stand for 30 min for precipitation of proteins. The solution was then centrifuged (10, 000 *g* for 25 min) and precipitated proteins were collected, neutralized and freeze dried for further analysis. The schematic flow sheet for preparation of meal and protein isolates is shown in Fig. 1.

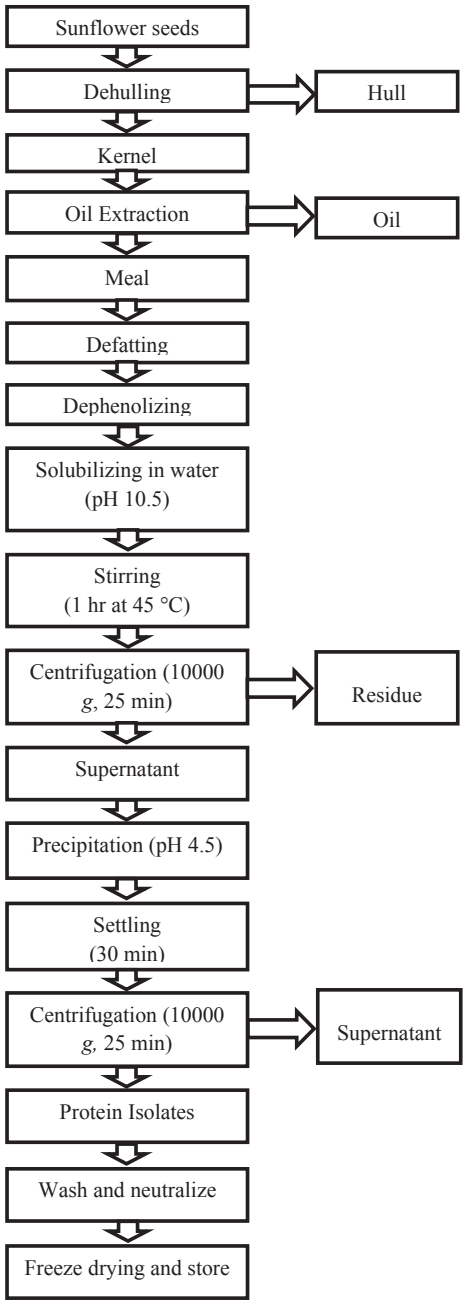


**Fig. 1.** Flow sheet for preparation of meal and protein isolates from sunflower.

### 2.4. Gamma irradiation of sunflower protein isolates

Sunflower protein isolates (10 g) were sealed in polyethylene bags (10 × 7.5 cm) and irradiated at different doses (10, 20, 30, 40 and 50 kGy) by 1.25 MeV $^{60}Co$ gamma source using 1200 Gamma Chamber (Interuniversity Accelerator Centre New Delhi, India) at an effective dose rate of 4.438 kGy/h. Ceric-Cereous dosimeter was used to measure the exact dose absorbed.

### 2.5. Colour measurement

The evaluation of colour of irradiated and non-irradiated sunflower protein isolates was measured using Hunter colorimeter model D 25 optical sensor (Hunter Associates Laboratory Inc., Reston, VA, USA) on the basis of $L^*$, $a^*$ and $b^*$ values. The color change (ΔE) after gamma irradiation was calculated using following equation:

$$\Delta E = \sqrt{(L_s - L)^2 + (a_s - a)^2 + (b_s - b)^2}$$

Where $L_s$ $a_s$ $b_s$ are the colour values of un-irradiated protein isolate isolates and L a b are the colour value of irradiated protein isolates.

### 2.6. Turbidity

The turbidity of sunflower protein solutions (1 g/100 mL) was determined by observing the absorbance at 600 nm at room