EFFECT OF DOMESTIC PROCESSING TECHNIQUES ON NUTRITIVE VALUE AND PESTICIDE RESIDUE DISSIPATION IN LEGUMES

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By

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CERTIFICATE

This is to certify that the thesis entitled **"Effect of Domestic Processing Techniques on Nutritive Value and Pesticide Residue Dissipation in Legumes"** being submitted by **Ms. Geetanjali Kaushik** to the Indian Institute of Technology Delhi for the award of degree of 'Doctor of Philosophy' is a record of bonafide research work carried by her. She has worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis. To the best of our knowledge the results contained in this thesis have not been submitted in part or full to any other University or Institute for award of any degree or Diploma.

(Prof. S.N. Naik) **(Prof. Santosh Satya)**

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"Yaa Devii Sarva Bhooteshu Vidya Roopena Samsthita

Namastasyai Namastasyai Namastasyai Namo Namaha"

(I bow to the Goddess, who dwells in all creatures in the form of knowledge)

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(Geetanjali Kaushik)

ABSTRACT

Ensuring safe quality food for an active mind and a healthy body is a multidimensional complex phenomenon requiring a holistic vision for pragmatic solution. The presence of pesticide residues in legumes coupled with the harmful antinutrients limits the bioavailability of the essential nutrients. Domestic food processing methods may provide a simple and effective solution in this context. Keeping this in view, the present study was undertaken to investigate the effect of common domestic processing techniques on the nutritive value and pesticide residue dissipation in legumes.

The experimental work carried out on two legumes namely, Chickpea (Cicer arietinum) and Soybean (Glycine max) reveals important findings. The nutrient content in processed food was found to vary with the legume genus. Out of all the processing methods selected, viz., soaking, soaking and germination, cooking (microwave, pressure and ordinary cooking), germination (day 1 in chickpea and day 2 in soybean) was found to be the best one resulting in overall maximum nutrient retention in the selected legumes.

In chickpea, germination leads to colossal increases in the riboflavin and niacin (~500%) content. Substantial increases were observed in the contents of reducing sugars (44%) and Cu, Fe and Zn (9-18%). Small but significant increases were also found in the total soluble sugar (6%) and crude protein (4%) content. Germination also resulted in noticeable declines (~55%) in the selected antinutrients. Germinated soybean (day 2) showed an increase in the sugars (10-32%) and crude protein content (15%). In minerals the losses for K, Mg and P (9-14%) were low, on day 2, while Ca, Zn, Mn (5-16%) and Cu showed increase in the content. Like chickpea germination, phenomenal increase in contents of riboflavin, niacin and ascorbic acid (~500%) were noticed on day 2 of germination. High reduction in antinutrients (50%) was also observed.

Chickpea is frequently stored for long duration in warehouses where successive sprays of different insecticides are applied to reduce the losses from storage pests. Therefore, it was important to understand the dissipation pattern of chlorpyrifos and its metabolites in chickpea grains under simulated storage conditions. Chickpea grains (filled in gunny bags with plastic sheets spread over them) were sprayed with recommended doses (6g a.i m^{-2}) of chlorpyrifos and simulated storage practice for duration of about 5 months. It was observed that chlorpyrifos and its metabolites oxon

and TCP were found in chickpea grains stored under above mentioned conditions. Even though the recommended doses of chlorpyrifos were used, the residue levels exceeded the MRL values right from the beginning of the storage period (after 30 days of storage, concentrations of chlorpyrifos, oxon and TCP were 4.61, 2.66 and 0.39 ppm respectively) and even a storage period of 5 months was not sufficient to bring the residues below safe levels (MRL).

The processes of soaking and germination and cooking of grains helped to eliminate most of the pesticide residues (93-99%). But, build up of toxic metabolite oxon during cooking (especially microwave and pressure cooking) can be a cause of concern for the consumers on account of its greater toxicity as compared to chlorpyriphos. Surprisingly, at 25ppm level of chlorpyrifos contamination, MW cooking generates almost 5.5 times more oxon than pressure cooking while in ordinary cooking oxon is not detected. The effect of chlorpyrifos residues on bioavailability of essential micronutrients in chickpea was investigated by simulated gastrointestinal digestion. It was found that chlorpyrifos residues did not impact the bioavailability of Fe and Zn but reduced the bioavailability of Cu (26%) and Mn (54%) at the highest spiking level of 25ppm.

Research findings of the present study reveal a strong possibility of providing safe and nutritious food from pesticide contaminated legumes using simple domestic processing techniques. Infact this study provides valuable insights into the complex issue of food quality and safety. Germination can serve as a simple technique for naturally fortifying legumes with essential minerals and vitamins.

Presence of pesticide residues may also hamper the bioavailability and assimilation of micronutrients by human body. Therefore in depth investigation on effect of different pesticides commonly used in grain storage systems on food safety and bioavailability of micronutrients is an important research area.

In view of contamination of food resulting in numerous health problems, dissipation of pesticide through processing techniques would prove a boon during the transient phase of agriculture system moving towards sustainable agriculture. Overall, present study shows a ray of hope in the current scenario of poor and unsafe food. However, the challenge lies in infusing these research findings for designing and developing a suitable food processing and cooking system and integrating it in the modern lifestyle, currently existing even in the rural sector of developing countries.

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