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Physical and Functional Properties of Raw and Roasted Garden Cress Seeds (*Lepidium sativum* L.) Flour

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ABSTRACT

Background: Garden cress is one of the traditional medicinal plants packed with nutrients. In India, garden cress seeds are consumed either raw or in processed forms. The different processes employed such as roasting may provide palatability, acceptable colour and texture and raise the content of carbohydrates along with retention of minerals.

Methods: The present study was conducted to assess the physical and functional properties of raw and roasted garden cress seeds flour. Raw garden cress seed flour was developed by drying the seeds in oven at 60°C for 45 minutes, followed by grinding and sieving through 60 mesh sieve. Roasted flour was developed by initial roasting of seeds in iron vessel followed by similar procedure as for raw flour. Both flours were stored in air tight containers for further research analysis. Physical properties assessed were thousand seed weight, seed volume, seed density, bulk density, hydration capacity, hydration index, swelling capacity and swelling index. Functional properties included water and oil absorption capacity, gel consistency, gelation capacity and flour solubility.

Result: The result for physical properties showed that thousand seed weight, volume, seed density, bulk density, hydration capacity, hydration index, swelling capacity and swelling index of raw garden cress seeds were 1.95 g, 2.6 ml, 0.77, 0.76 g/ml, 7.95, 4.05, 0.82 and 0.32, respectively, whereas, in roasted garden cress seeds, these were 1.81 g, 2.83 ml, 0.64, 0.69 g/ml, 7.21 g/100 g, 3.98, 0.88 ml/100 g and 0.31, respectively. Both raw and roasted garden cress seeds flour were found to have good functional properties. Data on functional properties showed that raw garden cress seed flour had significantly higher water absorption capacity (4.9 g/ml), oil absorption capacity (2.69 g/ml), gelation capacity (7.9%) and flour solubility (21.2%), while roasted seed flour had higher gel consistency (70.33%) than its counterpart. The study concluded thatboth types of flour *i.e.* raw and roasted garden cress seed flour were having good physical and functional properties implying that these can be incorporated into different food products so as to improve nutritional quality. The high flour solubility of garden cress flour makes it suitable for incorporating in different infant formulas.

Key words: Functional properties, Garden cress seeds, Physical properties, Roasting.

INTRODUCTION

The garden cress seed is an annual herb that thrives through out the Middle East, Europe and the United States. It is a member of Brassicaceae family, Kingdom Plantae, Division Magnoliophyta, Class Magnoliopsida and Order Brassicales. Garden cress is known as "*Halim*" in Urdu, "*Chand Shura*" in Sanskrit and "*Chansur*" in Hindi. According to scientific evidence, Ethiopia is the country where garden cress originated. Garden cress can grow in any climate and soil condition but for its cultivation, climatic condition of India is much favourable (Wadhwa *et al*., 2012). It is mostly grown in Gujarat, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra states of India.

The seeds physically resemble some oil seeds, with dicotyledonous endosperm accounting for 80-85 per cent of the seed content, while the seed coat and embryo account for 12-17 per cent and 2-3 per cent of the seeds, respectively (Mathews *et al*., 1993; Gopalan *et al.,* 2000). The garden cress seeds are used in various forms in foods as gelling agent, water retention agent, thickening agent, emulsifying agent and binding agent, primarily used as a main source of hydrocolloid (Singh *et al*., 2015). Physical and functional properties of food are significant in explaining their cooking and processing characteristics as they explain how foods perform in a system either as a processing aid or as a direct contributor of product characteristics (Oyebode *et al*., 2007).

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Quality of a food product is characterised by its structure, nutritional composition and acceptability. Garden cress seeds are rich source of protein and minerals such as iron and calcium, which emphasizes on the need of assessing its physical and functional properties. Therefore, the present study was conducted to analyze the physical and functional properties of raw and roasted garden cress seeds.

MATERIALS AND METHODS

The present study was conducted in Department of Foods and Nutrition, College of Home Science, G. B. Pant University

of Agriculture and Technology, Pantnagar, Uttarakhand with effect from January to August, 2021. In this study, physical and functional properties of raw and roasted garden cress seeds were analysed. For physical properties, whole seeds of garden cress were used whereas, seeds flour was used for functional properties analysis. Two types of flours were developed *i.e.* raw and roasted garden cress seed flour. For the development of raw GCS flour, seeds were cleaned manually and oven dried at 60±2°C for 45 minutes, followed by grinding and sieving through 60 mesh sieve. Roasted GCS flour was developed with the similar procedure as per the raw flour except that it was initially roasted in iron vessel for 3 minutes at 150°C. Both the flours were stored in air tight containers for further analysis.

Physical properties of seeds

Physical properties *viz.* thousand seed weight, seed volume, seeds density were estimated using methods of AOAC (2000). Bulk density was estimated by the method given by Wang and Kinsella (1976). Hydration capacity, hydration index, swelling capacity and swelling index were analyzed using the method given by Williams *et al.* (1983).

Functional properties of flours

Functional properties of flour *viz.* water and oil absorption capacity were measured by the method given by Lin *et al.* (1974). Gel consistency and gelation capacity were analysed by method given by Iyer and Singh (1997) and Singh and Singh (1991), respectively. Method of Subramanian *et al.* (1986) was used to estimate the flour solubility.

Statistical analysis

All the experiments under study were carried out in triplicates in order to reduce the variability among the results. Results were statistically analysed in terms of mean and standard deviation. One-way analysis of variance (ANOVA) was performed to determine significance of difference between two means at 1 and 5% level of significance.

RESULTS AND DISCUSSION

Physical characteristics of raw and roasted garden cress seeds

Physical qualities of seeds are critical for the design of handling, harvesting, aeration, drying, storage, dehulling and processing equipment. The results obtained for physical characteristics of garden cress seeds have been presented in Table 1. The results of the present study revealed that the mean weight of one thousand seeds was 1.95 g for raw seeds and 1.81g, for roasted seeds, which are non-significantly ($p<0.05$ per cent) different to each other. Similar results for weight of 1000 raw garden cress seeds was observed by Vaishnavi *et al.* (2020) *i.e.*, 1.86 g whereas higher value (2.5 g) was found by Gokavi *et al.* (2004). The weight loss with roasting may be due to loss of volatile material present in the seed, dehydration of moisture, pyrolysis and destruction of carbohydrates which are temperature dependent (Olapade *et al.,* 2012).

The seed volume of 1000 raw and roasted garden cress seeds was found to be 2.6 and 2.83 ml, respectively, which was significantly ($p<0.05$ per cent) different from each other. Seed volume is important it affects transport and handling. Gokavi *et al.* (2004) reported the seed volume of 1000 garden cress seeds as 3.3 ml. Seed density of raw seeds (0.75) was significantly ($p<0.05$ per cent) higher than roasted garden cress seeds (0.64) which are in accordance to the value quoted by Gokavi *et al.* (2004).

Bulk density of seed flours is determined by two key factors *i.e.* particle size and packing density. It is affected by polymer structure of starch of grain. As loose the polymer structure of starch, lower will be the bulk density (Iwe and Onadipe, 2001). Bulk density of raw and roasted garden cress seeds in present study was 0.76 and 0.69 g/ml, respectively, which are significantly different ($p<0.05$ per cent). Roasting might have affected moisture evaporation, which swells the seeds and disorganizes the starchy endosperm, resulting in a lower bulk density. Rajshri and Haripriya (2018) reported the bulk density of garden cress seeds as1.0±0.5 g/ml.

Hydration capacity is defined as ability of food or its components to store water under particular conditions. In the food sector, hydration capacity is crucial since it influences functional properties and the quality of baked goods. Hydration capacity of raw and roasted garden cress seeds in present study were found to be 7.95 and 7.21 g/100 g, respectively, whereas, the hydration index was as 4.05 and 3.98, respectively. The hydration capacity was found significantly different ($p<0.05\%$).

Swelling capacity is a measurement of a starch's ability to absorb water and swell (Iwe *et al.,* 2016).The swelling capacity is affected by the particle size, variety and processing methods. The degree of exposure of the internal structure of starch to the presence of water and the creation of the protein-amylose complex in starch molecules is indicated by swelling power (Pomeranz, 1991). Swelling capacity of raw and roasted garden cress seeds in the present study was determined as 0.82 and 0.88 ml/100 g, respectively, which were significantly different ($p<0.05$ percent) to each other. Swelling index was observed as 0.32 and 0.31, respectively. Higher hydration and swelling capacity allows the grain to absorb more amount of water thereby rendering the grains soft (Dobhal and Raghuvanshi, 2018).

Functional characteristics of garden cress seeds flour

Functional properties are the essential physicochemical properties of foods that reflect the complex interactions between the structures, molecular conformation, compositions, and physicochemical properties of food components with the nature of the environment and conditions in which these are measured and associated (Chandra and Samsher, 2013). Functional properties also describe the behaviour of ingredients during preparation and cooking, as well as how they affect the finished food products in terms of texture, taste and colour. The data on functional properties of raw and roasted GCS flour is given in Table 2.

Table 1: Physical characteristics of raw and roasted garden cress seeds.

Physical characteristics	Raw GCS	Roasted GCS	CD value
Thousand seed weight (g)	1.95±0.03	1.81±0.02	NS
Seed volume (ml)	2.60±0.05	2.83±0.03	0.214*
Seed density (g/ml)	0.77 ±0.02	0.64±0.02	0.059**
Bulk density (g/ml)	0.76±0.22	0.69±0.01	0.067**
Hydration capacity (g/100 g)	7.95±0.41	7.21±0.21	0.441**
Hydration index	4.05±0.34	3.98±0.27	NS
Swelling capacity (ml/100 g)	0.82±0.21	0.88±0.19	0.058*
Swelling index	0.32±0.06	0.31±0.09	NS

GCS: Garden cress seeds, Values are mean±SD of three independent observations.

**Significant at 1% level of significance, *Significant at 5% level of significance.

Table 2: Functional properties of raw and roasted garden cress seeds flour.

Functional properties	Raw GCS	Roasted GCS	CD value
Water absorption capacity (ml/g)	4.9±0.45	4.26±0.25	0.54**
Oil absorption capacity (ml/g)	2.69±0.1	1.98±0.21	0.107**
Gel consistency (mm)	47.33±0.97	62.54±0.81	2.74**
Gelation capacity (%)	7.90±0.04	5.60±0.23	0.66**
Flour solubility (%)	21.20±1.02	19.21±0.93	1.29*

Values are mean±SD of three independent observations; GCS: Garden cress seeds.

**Significant at 1% level of significance, *Significant at 5% level of significance.

Water absorption capacity is defined as the ratio of weight of water absorbed by any matter in saturated state over the weight of dry material. The water absorption capacity of raw and roasted seeds in present study was estimated as 4.9 and 4.26 ml/g, respectively, which are significantly different ($p<0.01$). The flour's high water absorption capacity indicates that it can be used to prepare sausage, dough and bread items. Flour's high WAC may be useful in goods demanding high viscosity, such as soups and gravies. Similar finding on water absorption capacity of garden cress seeds was observed by Rajshri and Haripriya (2018). A significant decrease in the water absorption capacity on roasting might be due to heat induced degradative effect of mucilaginous gums and high protein denaturation because of the exposure of more hydrophobic sites to temperature (Mudgil *et al*., 2014).

Oil absorption capacity of food is attributed to the physical entrapment of oil which may be advantageous in providing binding in food, particularly in flavour retention, palatability improvement and shelf life extension (Aremu *et al.,* 2007). In present study, oil absorption capacity of raw garden cress seeds (2.69 ml/g) was significantly higher ($p<0.01$) than roasted garden cress seeds flour (1.98 ml/g). These findings are in accordance to the findings of Toliba and Mohmed (2019) who reported oil absorption capacity of raw garden cress seed flour as 2.79±0.32 ml/g. The change in oil absorption capacity on roasting could be due to the partial denaturation of proteins with exposition of hydrophobic amino acid groups (Al-Ismail *et al.,* 2018).

The ability of starch granules to create gel (gel consistency) on heating is significant in the formation of baked items. The values for gel consistency of roasted garden cress seeds flour (62.54 ml/g) was significantly higher ($p<0.01$) than raw seeds flour (47.33 ml/g). The difference could be ascribed to the relative proportions of protein, carbohydrate and lipids in flours, as well as interactions between these components (Sathe *et al.,* 1982).

Physical competition for water between protein gelation and starch gelatinization influences flour gelation capability (Kaushal *et al.,* 2012). The significant difference ($p<0.01$) was observed in gelation capacity of raw and roasted garden cress seeds flour as 7.9 and 5.60 per cent, respectively. Flours containing high protein and starch have good gelation capacity.

Flour Solubility denotes the water soluble part of flour that can leach out during boiling or other processing. Flour solubility of raw garden cress seeds flour (21.2 per cent) was found to be significantly higher ($p<0.05$) than roasted seeds flour (19.21 per cent). High solubility of flour shows high digestibility. The flours with high solubility like garden cress flour can be used for development of various infant formulas.

CONCLUSION

Information on various physical and functional characteristics of garden cress seeds provides the data required for evaluating and retaining the quality of developed products and also gives indication of how they would behave in food system. Assessing solubility, swelling characteristics and gelation capacity will allow consumers realize the scope of reconstitution, which will improve the texture, consistency and presentation of baked stuff made with flours. The results of present study revealed that both raw and roasted GCS flours had good functional properties such as gel

consistency and flour solubility, which can be utilized in developing infant formulas.

Conflict of interest: None.

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