



Potential use of Partially Defatted Sesame (*Sesamum indicum* L.) to Combat Malnutrition

P. Nagar^{1,2}, M. Agrawal^{1,2}, K. Agrawal³

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ABSTRACT

Background: Sesame (*Sesamum indicum* L.) is one of the oldest oilseed crops grown worldwide. It is rich in protein and micronutrients. It is cultivated and used in different culinary preparations globally in various forms.

Methods: In the present study, defatting of mechanically dehulled white sesame seeds using an oil press machine at 200°C was done (local cultivar). This procedure could extract 50-60% oil from sesame seeds, therefore, it has been referred as partially defatted sesame seeds flakes or powder. The by-product, i.e., defatted sesame flakes, was evaluated for nutritional and anti-nutritional qualities. Mechanically dehulled sesame seeds of the same variety were used as a control. The defatted sesame flakes of seeds obtained were prepared in powdered form and assessed for biochemical parameters using standard methods.

Result: The defatting could reduce the fat content by 52.48 percent and increased the protein up to 40.35 per cent. Magnesium and zinc increased significantly. As defatting is done using an oil press machine, the nutrient retention was better in terms of bioavailability. The partially defatted sesame seed flakes had a good amount of protein, iron, zinc and magnesium with available other micronutrients and possess a good sensory quality having nutty flavor. The seed flakes can be a great source of food to cater to the nutritional needs of the population at large and to reduce malnutrition, especially in children. This can be used for value addition of various food products.

Key words: Defatting of sesame, Micronutrients, Nutritional quality of defatted seed flakes.

INTRODUCTION

Food processing plays a vital role in enhancing the nutritional value and increasing the shelf life of any food product (De Araújo *et al.*, 2022; García-Oliveira *et al.*, 2022). Sesame seeds are used in different forms including whole seeds, oil, meal cakes and other by-products for various food preparations worldwide and suitable for making healthy diets (Melo *et al.*, 2021; Nagar *et al.*, 2022; Wei *et al.*, 2022; Bansal *et al.*, 2022). It is one of the most common oilseeds grown and used directly along with its by-products at a large scale (Hafez, 2018). It contains significant amounts of macronutrients (protein) and micronutrients like calcium, iron, zinc, magnesium and phosphorus (Anilakumar *et al.* 2010; Longvah *et al.* 2017), that are crucial to maintaining our general health. Sesame has several pharmacological and nutraceutical benefits (Prasad *et al.*, 2012; Ha *et al.*, 2017; Pathak *et al.*, 2017; Sharma *et al.*, 2021). Sesame being a rich source of nutrients and, after processing, can be utilized as a functional meal (Zebib *et al.*, 2015; Aglave, 2018). One of the essential by-products of sesame, sesame oil cake, is a good source of protein (Melo *et al.*, 2021; Tzen, 2021). Pulses lack the amino acids viz. methionine, tryptophan and valine, whereas sesame seeds are rich in these nutrients (Sharma *et al.*, 2021).

Sesame seeds contain anti-nutrients like oxalate, phytate (Longvah *et al.*, 2017), tannin (Abou-Gharbia *et al.*, 1997; Embaby *et al.*, 2011; Okudu *et al.*, 2016; Deme *et al.*, 2017; Aglave *et al.*, 2018; Nagar *et al.*, 2022), etc. which hinder the mineral absorption by the body (Thakur and

¹Department of Home Science, University of Rajasthan, Jaipur-302 004, Rajasthan, India.

²Design Innovation Centre, Centre for Converging Technologies, University of Rajasthan, Jaipur-302 004, Rajasthan, India.

³Department of Life Sciences, Vivekananda Global University, Jaipur-303 012, Rajasthan, India.

Corresponding Author: Mukta Agrawal, Department of Home Science, University of Rajasthan, Jaipur-302 004, Rajasthan, India. Email: muktaahsc@gmail.com

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Thakur, 2019). Anti-nutrients can be decreased by processing methods (Thakur and Kumar, 2017; Thakur *et al.*, 2019; Popova and Mihaylova, 2019) like roasting, microwave heating, dehulling, germination, fermentation, etc. (Nagar *et al.*, 2022). Additionally, these techniques can increase nutrient bioavailability, enhance digestibility and lengthen shelf life.

Defatted sesame cake powder is used in bakery products (crackers) to enhance its nutritional value (Hafez, 2018; Lawal *et al.*, 2021), thereby improving protein digestibility as well (Akusu *et al.*, 2020). Food fortified with defatted sesame cake improves nutritional characteristics and enhances microbiological quality, thereby increasing

the shelf life of the food products (Prakash *et al.* 2018). Sesame is emerging as a functional food (Punia *et al.* 2021) and its byproduct defatted sesame seed cake have more functional properties (Gandhi and Srivastava, 2007) than the full-fat sesame seed (Lawal *et al.* 2021). Defatted sesame flour can be used to prepare foods for infants and children to prevent malnutrition (Ranganayaki *et al.* 2012; Uzo-Peters *et al.* 2018). Hence, defatted sesame seed cake can be further roasted to improve its nutritional and health benefits (Lawal *et al.* 2021; Sodipo *et al.* 2021; Nagar *et al.* 2023). Defatted sesame can be a great source of power-pack food rich in protein (Ranganayaki *et al.* 2012) and micronutrients such as iron, magnesium and zinc (Prakash *et al.* 2018) which can be used to combat nutritional deficiencies. Therefore, the present study was planned to evaluate the macro, micro and anti-nutrient contents of defatted sesame cake flour.

MATERIALS AND METHODS

The research work was carried out at the Design Innovation Centre, Centre for Converging technologies, University of Rajasthan, Jaipur during the year 2022 (August to December) in the following steps.

Collection of raw material

Samples of white mechanically dehulled sesame seeds of local variety were procured from the oilseed industry in a 5 kg lot in Jaipur city. The seeds were assessed after cleaning the dirt and extraneous matter.

Defatting

The whole mechanically dehulled sesame seed samples were defatted using an oil press machine at 200°C temperature and were estimated before (control) and after for macro, micro, antinutrients and total phenolic compounds. The oil yield ranged from 48-60 per cent therefore, it is referred to as partial defatting.

Sample preparation for biochemical evaluation

After processing, the obtained defatted flakes (by-products) were prepared in powder form in a household mixer grinder and packed in air-tight food-grade containers for different biochemical estimations using standard methods.

Macronutrients [moisture (oven drying), total ash (dry ashing), crude protein (Kjeldahl nitrogen), fat (Soxhlet extraction method), crude fiber (acid-alkali treatment), dietary fiber (enzymatic method) and carbohydrate (difference method)] were estimated by the methods given by AOAC (2019). The micronutrients (iron, calcium, magnesium, zinc) were estimated using ICP-MS as per the methods given by AOAC (2019). Bioavailable iron using the method given by Jain and Mogra (2019). Oxalates and phytates were estimated using the methods developed by Day and Under wood (1986) and Hassan (2011), respectively. The antioxidant activity was determined by estimating the total phenolic compounds using methods given in API (2016). These samples (nine samples each of control and partially defatted sesame) of control and partially defatted sesame seed powder were evaluated for nutritional and anti-nutritional quality.

Statistical analysis

Paired t-test was applied to check the effect of partial defatting of mechanically dehulled sesame seed. Comparative analysis was done based on the obtained p value at 5% and 1% levels of significance.

RESULTS AND DISCUSSION

Mechanically dehulled white variety of sesame oilseeds had 53.53 g of oil, 24.31 g of protein and 8.66 g of dietary fiber. Partial defatting could reduce fat content to 25.45 g while protein, crude fiber and dietary fiber increased to 40.75 g, 8.87 g and 11.90 g respectively (Table 1).

The levels of all the macronutrients estimated in defatted sesame seed flakes were significantly higher than whole mechanically dehulled sesame seeds. The increased ash content after defatting revealed that defatted sesame seeds were relatively better in terms of essential minerals like magnesium, zinc and iron especially (Table 1 and 2). Similar results were reported by Hassan (2011) and Bukya and Vijayakumar (2013). There was a significant increase in protein content which shows that defatted sesame seeds can be considered a more concentrated source of plant-based protein for developing food products (Melo *et al.* 2021; Abbas *et al.* 2022). With their higher

Table 1: Macronutrients present in white mechanically dehulled sesame and partially defatted sesame seed flakes powder.

Types of	Macronutrients (g/100 g)						
	Moisture	Total ash	Protein	Total fat	Crude fiber	Dietary fiber	Carbohydrate
sesame seeds							
Mechanically dehulled (Whole)	2.71±0.030	3.30±0.104	24.31±0.056	53.53±0.300	3.67±0.067	8.66±0.046	16.15±0.390
Partially defatted (Mechanically dehulled whole)	3.68±0.035	4.81±0.025	40.75±0.090	25.45±0.152	8.87±0.031	11.90±0.240	25.32±0.050
Level of significance	**	**	**	**	**	**	**

Values are Mean±SD (Nine samples of each-control and defatted).

Level of Significance- *P≤0.05=Significant, ** P≤0.01= Highly significant.

Table 2: Micronutrients present in white mechanically dehulled and partially defatted sesame seed flakes powder.

Types of sesame seed	Micronutrients (mg/100g)				
	Calcium	Magnesium	Zinc	Iron	Bio Available Iron
Mechanically dehulled (Whole)	54.35±1.384	377.33±3.804	5.39±0.057	8.17±0.224	2.55±0.021
Partially defatted (Mechanically dehulled whole)	57.47±1.426	520.45±6.292	7.00±0.047	8.41±0.040	1.60±0.011
Level of significance	NS	**	**	NS	**

Values are Mean ± SD (Nine samples of each- control and defatted).

Level of Significance- ^{ns}P≤0.05 = non-significant (NS), *P≤0.05=Significant, ** P≤0.01= Highly Significant.

Table 3: Antinutrients present in white mechanically dehulled and partially defatted sesame seed flakes powder.

Type of sesame seeds	Antinutrients (mg/100g)	
	Oxalates	Phytates
Mechanically dehulled (Whole)	1569.08±17.6169	643.6500±2.3750
Partially defatted(Mechanically dehulled whole)	2295.00±60.6218	724.1334±5.0895
Level of significance	**	**

Values are Mean ± SD (Nine samples of each- control and defatted).

Level of Significance -** P≤0.01= Highly Significant.

protein and lower fat content, the partially defatted seeds might be favored by those aiming to increase protein intake without a significant calorie contribution from fats (Melo *et al.*, 2021).

Defatted sesame cake flour was found to be better in micronutrients content when compared with full fat mechanically dehulled sesame as also reported earlier (Hassan, 2011; Uzo-Peters and Akinola, 2018). Defatted sesame meal was found to be having significantly higher magnesium and zinc while calcium and iron content were similar as control seed samples (white mechanically dehulled whole sesame) (Table 2). The bioavailable iron in partially defatted sesame seeds was less than the mechanically dehulled sesame (Table 3) which may be due to increase in oxalate and phytate content after defatting (Makinde *et al.* 2013). The variations in oxalate and phytate concentration across different sesame cultivars have been reported earlier by various authors (Embaby, 2011; Jimoh *et al.* 2011; Adegunwa *et al.* 2012; Makinde and Akinoso, 2013; Bukya and Vijayakumar, 2013; Zebib *et al.* 2015; Okudu *et al.* 2016; Om *et al.* 2020; Obeta *et al.* 2020; Rahimi and Gharachorloo, 2020).

Defatting sesame flakes can be roasted or fermented before utilization which will further reduce the oxalate and phytate content and increase the bioavailability of iron (Jimoh *et al.* 2011; Om *et al.* 2020). They can also be fermented to enhance the nutrient availability (Makinde *et al.* 2013; Om *et al.* 2020; Nagar *et al.* 2023).

CONCLUSION

Defatted sesame seed flour is an important functional food (due to presence of sesamol, sesamolin, sesaminol, sesamin, alpha tocopherol, omega 3 and 6 fatty acids *etc.*), sesame seeds are source of macro and

micronutrients to cater nutritional needs of every age group. Defatted sesame seed powder does not taste much fibrous in taste and provide nutty flavor of sesame thereby increasing its sensory quality. Sesame seeds are rich in lysine as well as methionine amino acids. Defatted sesame seed cake if supplemented to cereals or pulses will make a complete protein. Being defatted, sesame seed cake is high in energy, protein and mineral content, it is useful for value addition in low quantities for getting its benefits. Being high in energy, protein, iron, zinc and magnesium, it can be used as dietary supplements for children, adolescents, lactating women and other vulnerable sections of society to reduce protein energy malnutrition and anemia.

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Conflict of interest

Authors have no conflict of interest regarding this article.

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