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Assessment of Physical, Nutritional, Antioxidant, Antinutritional and Cooking Characteristics of Lentil Cultivar PL 8

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ABSTRACT

Background: From ancient times, lentil has been a prominent part of our diet. Nowadays, there is an emerging interest in lentil, as it is a potential food of plant origin having ample amount of nutrients, which contributes to numerous health benefits.

Methods: The seeds of lentil (PL 8) were screened for visual impurity and deformity and sound seeds were selected for further analysis. The seeds were subjected to milling and the flour obtained was further used to analyze the physical parameters, nutritional quality, antinutrient content and cooking characteristics of the chosen variety. The impact of soaking on cooking quality was also observed.

Result: It was observed that lentil (PL 8) seeds had higher content of protein, dietary fibre and anti oxidants. However, the antinutrient content as well as physical properties were comparable with the other varieties studied by various authors. It was further observed that soaking of seeds prior to cooking reduced cooking time.

Key words: Cooking quality, *In vitro* Protein Digestibility, Lentil, PL 8, Total dietary fibre.

INTRODUCTION

Pulses, as defined by Tyler *et al.* (2017) are dried edible seeds of family Fabaceae (*leguminosae*) including chick pea, faba bean, lentil, field pea and so on. However, Mudryj and Aukema (2014) stated that legumes that are used for oil extraction such as peanuts or soybean or those harvested green for food as green peas or green beans are excluded from the list of pulses. As per the data India and Egypt are the largest pulse consumers in the world. In these countries people fulfill their protein requirement through pulses in contrast to their western counterparts (Rochfort *et al.,* 2007). In the west, Spain, UK and France predominantly consume about 60% of the total pulses produced in Europe. As per Derbyshire *et al.* (2011) it needs to be highlighted that each region has its own way of preparing pulses that varies around the globe. Since ancient times pulses have been recognized and celebrated as being one of the most important food crops having superior nutritive value and health promoting attributes (Tiwari and Singh, 2012). Pulses being rich in proteins, complex carbohydrates, vitamins and minerals are nutrient dense andhave been recommended by many health organizations to be consumed as staple food in order to meet the basic protein and energy requirements of the human diet (Leterme, 2002; Singh *et al.,* 2015). According to Kaur *et al.* (2013) pulses should be included in the daily diet in order to manage or prevent the risk of prevailing lifestyle diseases such as obesity, diabetes and cardiovascular diseases.

Among the commonly consumed pulses, Aguilera *et al.* (2010) postulated that lentil (*Lens culinaris* L.), is a widely grown pulse and dietary staple in many countries particularly Canada, India, Africa, Australia and America and it has been found to be an optimal dietary source of vital nutrients possessing high antioxidant capacity. It is a rich source of dietary fibre, complex carbohydrates, proteins, vitamins and minerals (Costa *et al.,* 2006). Roy *et al.* (2010) reported that the nutritional content of lentil is associated with the lipid and cholesterol lowering effects in humans together with decreasing the incidences of type 2 diabetes and colon cancer. Lentil along with being one of the ancient and the most commonly consumed legumes in the world (Salman and Hasan, 2014) is not only rich in essential macronutrients but possesses less than 1% fat (Wang and Toews, 2011) while the level of protein is around 20.6-31.4% (Urbano *et al.,* 2007). Joshi *et al.* (2017) postulated that the protein content in lentil seeds and meat is almost similar.

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Thavarajah *et al.* (2011) stated that other than the ease of cooking and decortications compared to most other grain legumes, lentil has accounted for the increased global per capita consumption of pulses over past 50 years and has represented itself as a potential crop that can improve human nutritional status on a global scale. Apart from its nutritional and medicinal values, low levels of antinutrients and an ability to grow in limited amount of water make lentil a potential crop for conservation agriculture, particularly in arid and semi-arid regions (Salem *et al.,* 2014).

The present study was carried out to assess the nutritional profile, antinutritional content and cooking quality of PL 8 lentil variety of GBPUAT, Pantnagar, which is the best small-seeded variety, developed by the institute till date and has been released centrally since 2010. It is a cross of variety DPL 59 and IPL 105 and is basically the most preferred variety to be grown in north western plains (Punjab, Haryana, Plains of Uttarakhand, Western U.P., Delhi and Rajasthan) of the country. Its average yield is about 15 quintals/hectare and takes around 135 days to mature. Hence, the current study was plannedin order to gain an insight of its nutrient content so that its potential utilization and consumption can be further enhanced.

MATERIALS AND METHODS

The study was carried out in the Department of Foods and Nutrition, College of Home Science in G.B. Pant University of Agriculture and Technology, Pantnagar, w.e.f. July, 2022-September, 2022.

Procurement of raw material

Lentil seeds (PL 8 variety) were procured from Crop Research Centre, GBPUAT, Pantnagar. The seeds were cleaned for any visual impurity or deformity. After proper cleaning and drying in an oven at 50±2°C for 24 hours, seeds were ground to 125 µm particle size using Inalsa mixer grinder and kept in air tight polypacks for further analysis.

Chemicals

All chemicals used in this study were of analytical grade.

Assessment of physical parameters of lentil (PL 8) seeds

Various parameters *viz*. hundred seed weight, hundred seed volume, seed density, hydration capacity, hydration index, swelling capacity and swelling index were analyzed by the method reported by Williams *et al.* (1983). The three major perpendicular dimensions of the lentil kernel *i.e*., length (L), width (W) and thickness (T) were determined using vernier caliper (Mitutoyo Corporation, Japan) having least count of 0.02 mm. Geometric mean diameter (Dg) and sphericity index were calculated by using method of Mohsenin, (1980). The lentil seed volume and surface area were calculated following the method of Jain and Bal (1997).

Proximate composition

The moisture content, total ash, crude protein, crude fat and crude fibre were determined by AOAC (2012). Evaluation of total carbohydrate content (Merrill and Watt 1973), available carbohydrate (FAO, 2003) and physiological energy (Mudambi and Rao, 1989) was also carried out.

In vitro protein digestibility and total dietary fibre content *In vitro* protein Digestibility was determined by protocol given by Akeson and Stahman (1964) and estimation of total dietary fiber was done adopting the method given by Asp and Johansson (1981).

Estimation of anti nutrient contentin lentil (PL 8) seed powder

Phytic acid content was determined using the protocol determined by Jain and Mogra (2006). The content was calculated using the expression:

Phytin phosphorus (mg/100 g) =

$$\frac{\text{Weight of dried precipitate}}{\text{Weight of sample}} \times 100$$

(values were expressed as g/100 g).

Tannic acid was estimated by colorimetric method according to the procedure given by AOAC (2012).

Estimation of antioxidant content in lentil (PL 8) seed powder

Methanol extract of the flour was prepared to analyze the total phenol (Singleton *et al.,* 1974) and total flavonoid (Zhishen *et al.,* 1999) content.

Determination of cooking quality of lentil (PL 8) seeds

The cooking quality of the chosen seeds was determined by estimating the total time required for achieving maximum amount of cooked seeds. Cooking time of lentil seeds was determined using both open pan and pressure cooking methods. The cooking of different seeds was carried out with and without presoaking step for different time periods. After cooking, samples were tested for their softness as per the method given by Singh *et al*. (1991). The time required to obtain hundred per cent cooked seeds was recorded as the cooking time. Following methods wereused for assessment of cooking quality:

1. Open pan cooking without pre soaking.
2. Open pan cooking after soaking.
3. Pressure cooking without pre soaking.
4. Pressure cooking after soaking.

Statistical analysis

Experimental results were obtained in triplicates and were further analyzed by Microsoft Excel data analysis (v.2007) tool pack software.

RESULTS AND DISCUSSION

Assessment of physical parameters of lentil (PL 8) seeds

The results of physical parameters are summarized in Table 1. Measurement of physical parameters is important to determine the quality of the grain. Pant lentil 8 (PL 8) is a popular improved variety. The physical parameters studied

included seed weight, seed volume, seed density, hydration capacity, hydration index, swelling capacity, swelling index, length, width, thickness, geometric mean diameter (Dg), sphericity index (ϕ), kernel volume, kernel surface area (S) and grain hardness were determined and Hundred seed weight of lentil (PL 8) seeds was found to be 1.82 g. The lentil seeds used in present investigation were of microsperma type as the weight of 100 seeds was below 2.5 g (Sharma *et al*., 2014). Rani and Grewal (2014) observed 1000 grain weight in a wide range of 19.30-32.40 g in selected six varieties of lentil. Hundred seed volume of lentil (PL 8) seeds was found to be 1.97 ml. Jood *et al*. (1998) reported the seed volume of 0.021 to 0.025 ml/seed in three lentil varieties. Seed density of lentil (PL 8) was calculated as 0.93 g/ml. Rani and Grewal (2014) reported seed density of six varieties of lentil in the high range of 1.19-1.31 g/ml whereas Jood *et al*. (1998) made observations similar to the present study (0.82 to 0.93 g/ml) in three lentil cultivars. Hydration capacity (0.012 g/seed) and hydration index (0.67) of lentil (PL 8) seeds were found to be comparable with that observed by Jood *et al*. (1998) among three lentil varieties with values ranging from 0.019-0.026 ml/seed for hydration capacity and for hydration index of six lentil varieties the values ranged from 0.83-1.05 as reported by Rani and Grewal (2014). Rani and Grewal (2014) reported hydration capacity of 0.018-0.030 g/seed in six varieties of lentils. Swelling capacity and swelling index of lentil (PL 8) seeds were calculated as 0.011 ml/seed and 0.58, respectively. Swelling capacity of 0.018-0.025 ml/seed of three lentil varieties was reported by Jood *et al*. (1998). Rani and Grewal (2014), reported 0.030-0.050ml/seed of swelling capacity in six varieties of lentils. A very high range of swelling index (1.05 to 1.47) has been reported by Rani and Grewal (2014) in six varieties of lentils.

Table 1: Assessment of physical parameters of lentil (PL 8) seeds.

Physical parameters	Values#	CV*
Hundred seed weight (g)	1.82±0.02	0.01
Hundred seed volume (ml)	1.97±0.06	0.03
Seed density (g/ml)	0.93±0.03	0.03
Hydration capacity (g/seed)	0.01±0.00	1.06
Hydration index	0.67±0.05	0.07
Swelling capacity (ml/seed)	0.01±0.00	0.18
Swelling index	0.58±0.14	0.24
Length (mm)	3.39±0.16	0.02
Width (mm)	3.24±0.15	0.02
Thickness (mm)	2.18±0.11	0.01
Geometric mean diameter (mm)	2.88±0.10	0.01
Sphericity index (%)	85.07±2.15	4.64
Kernel volume (mm^3)	10.29±1.05	1.11
Kernel surface area (mm^2)	23.24±1.56	2.44
Grain hardness (kgf)	8.12±0.63	0.40

#Values are mean±SD (n=10). (S. No. 1-7: Durgapal *et al.,* 2020)

*Coefficient of variance.

Table 2: Nutritional quality of lentil (PL 8) seeds (Dry weight basis).

Variables	Mean±SD*	CV*
Ash (g/100 g)	2.18±0.03	0.01
Moisture (g/100 g)	7.83±0.28	0.08
Crude fat (g/100 g)	2.27±0.15	0.02
Crude protein (g/100 g)	28.18±0.28	0.08
Crude fibre (g/100 g)	3.34±0.14	0.02
Total carbohydrate (g/100 g)	59.68±0.61	0.37
Physiological energy (g/100 g)	300.09±2.26	0.51
% *In vitro* protein digestibility	75.31±0.31	0.02
Soluble dietary fibre (g/100 g)	4.3±0.12	0.07
Insoluble dietary fibre (g/100 g)	13.7±0.26	0.01
Total dietary fibre (g/100 g)	18.0±0	0.0

#Values are mean±SD (n=6).

*Coefficient of variance.

Table 3: Antioxidant potential of lentil (PL 8) seeds.

Variables	Total phenol content mg GAE/g	Total flavonoid content mg QE/g
Mean±SD	17.07±0.31	18.14±0.30
CV	0.09	0.09

#Values are mean±SD (n=6).
*Coefficient of variance.

Table 4: Anti nutrient content in lentil (PL 8) seeds.

Variables	Phytic acid	Tannin
Mean±SD	0.27±0.02	5.93±0.23
CV	-	0.05

#Values are mean±SD (n=6).
*Coefficient of variance.

The observed values for length (3.39±0.16 mm), width (3.24±0.15), thickness (2.18±0.11) and geometric mean diameter (GMD) (2.88±0.10) of PL 8 seeds were slightly lower than the values reported by Kumar *et al.* (2016) for PUSA 4076 (Shivalik) lentil variety whereas, in the context of sphericity (ϕ) and surface area (S), the two varieties were found to be much different with values for PL 8 (ϕ= 85.07%, S=23.24 mm^2) and PUSA 4076 (ϕ= 81.48%, S= 37.95 mm^2), respectively. The kernel volume of PL 8 seeds was found to be 10.29 mm^3. The grain hardness of the selected lentil seeds (8KGf) was found to be in accordance with the value range (8-11KGf) reported by Rani and Grewal (2013) who analyzed 6 Hissar lentil seed varieties for the same.

Nutritional quality of lentil (PL 8) seeds (Dry weight basis)

The results of nutritional quality assessment of PL 8 seeds have been presented in Table 2.

The data on the proximate composition of PL 8 lentil variety showed that the protein content was found to be 28% on dry weight basis which was much higher than that reported by Gupta *et al.* (2021) who worked on 8 released Indian lentil varieties including PL 8. They reported PL 6 variety having the highest protein content with 26.52%, while the value for PL8 was in the range with the value 21-31% reported by Romano *et al.* (2021). The observed range for the crude fat and crude fibre of PL 8 seeds were 2% and 3%, respectively and this was in accordance with the data reported by Solanki *et al.* (1999) in context of crude fat, however the crude fiber content of PL 8 was higher than the reported mean crude fibre content (1.12%) as per (Solanki *et al.,* 1999). The moisture (7.8%) content of PL 8 seeds was found to be comparable with the values reported by Solanki *et al.* (1999) who assessed two newly released varieties (LH 37 and LH 97), while the ash content (2.18%) of PL 8 lentil seeds was seen to be slightly lower than the range 2.6-2.9%, as reported by Dhinsa *et al.* (1985) who studied six Indian lentil varieties (Pusa-4, Pusa-6, L-9-12, Pant 234, Pant 406 and T-36). The values for physiological energy observed in the study (300 g/100 g) was significantly lower than the values given by Dhinsa *et al.* (1985) (405-429 Kcal/100 g) and Solanki *et al.* (1999) (360.7 Kcal/100 g). The total carbohydrate content (59.7%) was comparable with the mean value of 60.2% as reported by Solanki *et al.* (1999).

The values observed for the total dietary fibre content was 18 g/100 g and it was in accordance with the range of 10±1 to 21±1 g/100 g given by Singh *et al.* (2015) who studied 30 different lentil genotypes. In the context of *In vitro* Protein Digestibility, the observed value of 75% was significantly higher than the reported value range of 64.2-69% by Dhinsa *et al.* (1985) whereas, it was in range with values (75.9-77.5%), given by Barbana *et al.* (2013).

Antioxidant potential of lentil (PL 8) seeds

The results of antioxidant composition of PL 8 lentil seeds have been presented in Table 3.

The total phenol content of the PL 8 lentil seeds were observed as 17.07 mg GAE/g, which was in accordance with the value (>17 mg GAE/g), given by Gupta *et al.* (2021) who further reported PL8 as one of the lentil varieties having highest total phenol content among other Indian lentil varieties. Similarly, the flavonoid content of the selected lentil variety was recorded as 18.14 mg QE/g that is comparable with the values (17.26 mg QE/g) reported by Gupta *et al.* (2021) for the same PL8 lentil seed variety.

Anti nutrient content in lentil (PL 8) seeds

The results for anti nutrient content of PL 8 lentil seeds have been presented in Table 4.

The observed mean value for phytic acid was 0.27 g/100 g, which was slightly higher than the values (0.19 g/100 g), as reported by Ghavidel and Prakash (2007). However, it was comparable with the range of 0.25-0.38 g/100 g, as given by Pal *et al.* (2017) who studied five different lentil varieties. Tannin content of PL 8 lentil seeds was observed to be 5.93 g/100 g, which was in the range of 5.14-9.38 g/100 g, as given by Pal *et al.* (2017) however it was significantly higher than the values (0.75 g/100 g) reported by Ghavidel and Prakash (2007).

Determination of cooking quality of lentil (PL 8) grains

The results for determination of cooking quality of PL 8 lentil seeds have been presented in Table 5.

Data on the cooking characteristics of PL 8 Lentil seeds showed that pressure cooking is comparatively a better method than open pan cooking to obtain greater percentage of cooked grains. Findings of the study also depicted that soaking prior to cooking reduces the cooking time significantly and this finding was in accordance with the results given by Huma *et al.* (2008) who established that soaking before cooking brings about 50% of reduction in cooking time of lentil.

Table 5: Determination of cooking quality of lentil (PL 8) grains.

Treatment	Percentage of cooked grains (% Mean±SD)			
	100 min	80 min	60 min	40 min
Open pan cooking without soaking	97.67±0.57	95.67±0.57	77±1.00	71.33±0.57
	30 min	25 min	20 min	15 min
Pressure cooking without soaking	99.67±0.57	88.67±0.57	62.67±1.15	32.67±0.57
	25 min	20 min	15 min	10 min
Open pan cooking with soaking	96.33±0.57	93±0	90.33±0.57	84.33±0.57
	10 min	8 min	6 min	4 min
Pressure cooking with soaking	98.33±0.57	94±0	92.67±0.57	85.33±1.15

CONCLUSION

The data of physical parameters showed that the selected PL 8 lentil seeds were almost similar to the varieties analyzed earlier while there were ample difference in certain attributes like surface area, kernel volume and sphericity. However the nutritional content of the selected variety was almost in range with the data reported previously except for the crude protein and dietary fibre content in which PL 8 was found to be considerably high. Data on cooking quality depicted that pressure cooking results in greater percentage of cooked grains and soaking prior cooking is an effective way to reduce total time required for the purpose. In context of anti oxidant content the chosen variety has amounts in range sufficient to refer it to as having the highest potential among other lentil variety, however the content of phytic acid and tannins were quite low and might further decrease by cooking. The dietary fibre amount was also found to be higher much to term it as fibre rich. Therefore, the information generated through the study will be helpful in promoting its production among farmers and popularize its consumption among the predominant pulses consuming population of the nation.

Conflict of interest

All authors declared that there is no conflict of interest.

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