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Effect of Cooking Methods on the Total Phenolic Content and Antioxidant Activity of the Commonly Consumed Pulses

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Abstract

The effect of various cooking methods on the antioxidant activity of commonly consumed pulses was studied. Raw and processed pulses were analyzed for their antioxidant activity and total phenolic content. The antioxidant activity of the raw pulses ranged from 64.1to 95.3 % inhibition, with the highest value in red kidney beans and lowest in moth beans. Maximum retention of antioxidant activity was observed in microwave cooked pulses with mean retention of 89.3% whereas minimum retention was observed in germinated pulses with mean retention of 74.4%. Total phenolic content of the raw pulses varied from 52 to 313 mg/100g whereas the corresponding values in cooked pulses ranged from 45 to 263mg/100g. The reduction of total phenolic content might be due to the differences on distribution and content of phenolic compounds in the seed coat and cotyledon between tested seeds. The study recommended that microwave cooking was the suitable method for retaining maximum AOA in the pulses followed by pressure cooking.

Key words: Pulses; Cooking methods; DPPH; Antioxidant activity; Total phenolic content; Proximate composition.

Introduction

Pulses are also recognized as a food choice with significant potential health benefits. They represent an important source of protein for vegetarians and have a low glycemic index. Pulses contain complex carbohydrates (dietary fibres, resistant starch and oligosaccharides), protein with a good amino acid profile (high lysine), important vitamins and minerals (B vitamins, folates and iron) as well as antioxidants and polyphenols .[1] Pulses also contain enzyme inhibitors, lectins, oligosaccharides, polyphenols, phytates and saponins-also known as antinutritional factors (ANF's) - that affects the digestibility and bioavailability of nutrients in humans and animals. Pulses also contain tocopherols, flavonoids and isoflavones, all of which can act as antioxidants. The processing of pulses inhibits or reduces the activity of these compounds.[2]

Antioxidants are our first line of degree against free radicals damage and are critical for maintaining optimum health and well-being.[3] Antioxidants are the substances that delay or inhibit oxidative damage when present in small quantities compared to an oxidizable substrate. Therefore, antioxidants can help in increase prevention by effectively quenching free radicals or inhibiting damage caused by them.[4]

Although dry pulses do not contain any ascorbic acid, the germinated pulses and immature green pulses do contain ascorbic acid which also has antioxidant activity.[5] From the nutrition point of view, only thermally processed pulses are important since pulses are never eaten raw. A factor that is attributed for the less use of legumes is it being hard-to-cook. A variety of processing methods have

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been practiced such as soaking, germination and cooking.[6] Soaking, boiling and steaming processes significantly affected the total phenolic contents and antioxidant activities. The food processing methods including soaking, pressure cooking, microwave cooking, germination and fermentation greatly influence nutritive values of legumes. Of these cooking and germination plays an important role as it influence the bioavailability and utilization of nutrients.[7]

However, how processing methods effects health promoting phenolic and antioxidant activities have not been studied. Little information is available in literature regarding the effect of cooking on changing the health promoting phenolic content and antioxidant activity of the commonly consumed legumes.

Materials and Methods

Procurement of samples

Five commonly consumed whole pulses namely; Bengal gram, black gram, green gram, moth beans and red kidney beans were purchased from the three markets of Ludhiana city namely Dugri Phase-I, Ghumar Mandi and Jawahar Nagar. Each pulse was collected from the three outlets of each market, the samples of which were pooled and considered as single sample of that pulse. Collected samples were thoroughly cleaned of dirt, insects and unwanted particles.

Cooking of pulses

Five hundred grams of each pulse was divided into five equal portions. One portion was retained as raw while others were cooked using cooking methods viz. soaking, germination, pressure cooking and microwave cooking. Each processing method was carried out using soaked pulses and time taken by cooking was also standardized.

Soaking

One hundred gram of each sample was soaked in the tap water for 10 hours. Excess water was drained and soaked grains were dried in dehydrator at 60°C.

Table 1.1: Processing/ cooking time (min) of pulses

Pulses	Germination (h)	Pressure cooking (min)	Microwave cooking (min)
Bengal gram whole	24	25	35
Black gram whole	24	15	25
Green gram whole	16	10	20
Moth beans	16	15	20
Red kidney beans	36	25	30

Germination and Steaming

The soaked grains were allowed to germinate at room temperature for specific time period varied for different pulses (Table 1.1). The germinated seeds were pressure steamed at 15 lbs for 2 mins.

Pressure Cooking

Soaked pulses were pressure cooked for specific time period for different pulses at 15lbs pressure (Table 1.1).

Microwave Cooking

Pulses were cooked in the microwave oven at 2450 MHz specific time period for different pulses (Table 1.1).

All the cooked samples were dried at 60±2^{0}C till these were moisture free. Dried samples were powdered in an electric grinder. The powders were sieved to obtain homogenized powder and stored in airtight containers for further analysis.

Preparation of extracts for the determination of total phenolic content (TPC) and antioxidant activity:

One gram of finely ground sample was taken into a spout less beaker and 25ml of 70% methanol was added. The contents were refluxed for 2 hours and then filtered.

Table 1.2: Effect of cooking method on TPC in pulses

Pulses	Raw	Soaking	Germination & steaming	Pressure cooked	Microwave cooked	CD at 5%
Bengal gram whole	153±5.5	142±6.4	140±10.4	73±4.4	63±0.8	19.9
Black gram whole	285±6	155±12.3	249±4.6	261±34.7	263±21.7	60.9
Green gram whole	313±4.8	192±15.4	235±6.8	246±37.7	247±3.0	58.8
Moth beans	52±3.5	125±26.7	87±15.3	134±6.8	45±28.7	60.3
Red kidney beans	302±17.9	243±20.0	167±27.2	253±3.0	232±4.1	55.4
Mean	221±51.2	171±21.01	176±30.1	193±16.9	170±47.6	-

Methanol was evaporated and the volume of the remaining water extract was made to 10ml. The extracts were used for the determination of TPC and antioxidant activity.

Estimation of total phenolic content

Total phenolic content was estimated by modified method given by Singleton *et al* (1999).[8] Methanolic extract (0.1ml) was dissolved in 6.5ml of distilled water. To this, 0.5 ml of Folin Phenol reagent was added and shaken thoroughly. After 5 min, 1 ml of saturated solution of sodium carbonate was added. The blue color developed was read after 1 hour at 760 nm against the blank. The blank was prepared from reagents and water only. The concentration of total phenols was read from the standard curve, prepared by using Gallic acid at the concentration ranging between 10-50µg/ml.

Evaluation of antioxidant activity of whole pulses using DPPH method

Estimation was carried out by method given by Sreeramulu et al (2009).[9] 0.1ml of aliquot of sample extract was taken in a test tube and then 2.9ml of 0.05mM DPPH reagent was added and vortexed vigorously. The content was incubated in the dark for 30 min at room temperature. Discoloration of DPPH was

Table 1.3: Effect of cooking method on AOA in pulses

Pulses	Raw	Soaking	Germination & steaming	Pressure cooked	Microwave cooked	CD at 5%
Bengal gram whole	66.9±2.6	52.9±5.2	45.3±6.0	48.1±2.2	49.7±5.4	NS
Black gram whole	90.9±3.0	43.4±2.6	58.1±3.1	83.1±2.4	84.7±0.9	7.98*
Green gram whole	84.5±2.7	73.0±8.7	84.4±2.2	84.1±0.2	83.8±0.9	NS
Moth beans	64.1±12.9	46.6±3.6	28.5±3.1	63.9±7.1	48.9±10.6	NS
Red kidney beans	95.3±0.3	91.6±0.6	91.6±0.1	73.8±3.3	92.1±1.4	5.5*
Mean	80.38±6.3	61.56±9.1	61.64±11.8	70.64±6.7	71.82±9.3	-

Table 1.4: % retention of Antioxidant activity of raw and processed pulses

Pulses	Soaking	Germination & steaming	Pressure cooking	Microwave cooking
Bengal gram whole	79.1	67.7	71.9	74.2
Black gram whole	47.7	63.9	91.4	93.2
Green gram whole	86.4	99.9	99.5	99.2
Moth beans	72.7	44.5	99.7	76.3
Red kidney beans	96.1	96.1	77.4	96.6
Mean	76.6	74.4	87.8	89.3

measured against blank at 517 nm.

Results and Discussion

Total phenolic content: The raw samples had 313.3±4.79 to 52±3.46 mg/100g of total phenolic content with the mean value of 221.1±51.2. The results found in present investigation is supported by Sreeramulu *at el* (2009)[9] who reported the range of 62.35-418.34 mg/100g with value of in 194.9±9.6 Bengal gram, 418.34±12.57 black gram dhal,62.35±4.31 green gram, 332.98±8.06 rajmah.

The processed samples had 142±6.4 to 243±20.03, 87.5±15.3 to 249.1±4.61, 73.3±4.38 to 260.8±34.7, 45±28.7 to 263.3±21.7 percent values for soaking, germination, pressure cooked and microwave cooked samples with mean of 171.4±21.01, 175.8±30.12, 193.4±16.95, 169.9±47.63 respectively. Among the raw pulses, moth beans had the lowest and green gram had the highest value. Among soaking, germination, pressure cooked and microwave cooked pulses, moth beans and red kidney beans, moth beans and black gram, Bengal gram and black gram , moth beans and black gram had the lowest and the highest value of total phenol content.

The trend showed that in comparison to raw samples there was significant decline in the total phenolic content in processed samples and among various cooking methods microwave cooked samples had the lowest content of total phenolic content followed with soaking, germination while the pressure cooked samples had the highest value. For processed value, Xu and Chang (2008a)[10] supported the trend that the total phenolic content of processed cool season food legumes was significantly reduced as compared to the raw samples. After soaking, the loss in TPC in peas and chickpeas decreased with soaking and pressure cooking lost more TPC than regular cooking.

The reduction in phenolic content during cooking may be due to binding of polyphenols with other organic substances and proteins, or form alterations in the chemical structure of polyphenols. The reduction of total phenolic content might be due to the differences on distribution and content of phenolic compounds in the seed coat and cotyledon between tested seeds. Boateng *et al* (2008)[11] also supported that although soaking and cooking dry beans have been shown to reduce the antinutrients such as trypsin inhibitor and reduce phytic acid; it can also increase the contents of tannins, catechins and polyphenols.

Dewanto et al (2002)[12] explained that thermal processing may release more bound phenolic acids from the breakdown of cellular constituents which might be the cause of increase in TPC of moth beans after processing. Siddhuraja and Becker (2006)[13] observed that total phenolic content were significantly (pd"0.05) higher after soaking and dry heating compared to cooking (boiling) of autoclaving

of both raw and presoaked seeds. Further, an increase in phenolic content primarily depends on the type of legume and the preparation procedure used. Negi *et al* (2008)[14] observed a decrease in phenolic content during cooking (soaking, germination, pressure cooking and microwave cooking) which may be due to binding of polyphenols with other organic substances and proteins, or form alterations in the chemical structure of polyphenols.

Antioxidant activity

The antioxidant activity of the raw samples ranged from 64.1±12.9 to 95.3±0.28, with the highest value in red kidney beans and lowest in moth beans. The mean value of raw pulses was found to be 80.38±6.31. Among the raw samples, moth beans and red kidney beans had the lowest and highest value of antioxidant activity respectively. In processed samples, the antioxidant activity was observed as 43.4±2.65 to 91.6±0.57 in soaking, 28.5±3.05 to 91.6±0.15 in germination, 48.1±2.25 to 84.1±0.23 in pressure cooked and 48.9±10.56 to 92.1±1.38 in microwave cooked pulses with mean value 61.56±9.09, 61.64±11.8, 70.64±6.71, 71.82±9.3 respectively. In processed samples, black gram and red kidney beans, moth beans and red kidney beans, Bengal gram and green gram, moth and red kidney beans had the lowest and highest value in soaking, germination, pressure cooked and microwave cooked pulses respectively.

In comparison to raw pulses there was significant decrease antioxidant activity with soaking followed by germination, pressure cooking & microwave cooking. Xu and Chang (2008a) observed that after processing, the DPPH free radical scavenging capacities (DPPH values) of processed cool season food legumes were significantly reduced as compared to the respective original unprocessed cool season food legumes. [10]After boiling, free radical scavenging capacities of cool season food legumes were reduced about 60-70%. After steaming, free radical scavenging capacities of cool season food legumes were reduced.

It was observed that maximum retention of antioxidant activity was observed in microwave cooked pulses with mean retention of 89.3% whereas minimum retention was observed in germinated pulses with mean retention of 74.4%.

The results are being supported by Xu B, Chang S K C (2008b)that the DPPH free radical scavenging capacities of processed beans was significantly reduced as compared to the respective unprocessed black beans.[15] Siddhuraja (2006)[13] stated that the stability of antioxidant products such as phenolics and flavonoids during heating may be due to the formation of milliards products such as hydroxymethylfurfuraldehyde (HMF) which produces high antioxidant activity.

Conclusion

Investigation revealed that pulses were an important source of antioxidant activity in commonly consumed diet.

Processing/cooking methods significantly decreased the total phenolic content and antioxidant activity in pulses. Maximum decrease in AOA was observed in soaked samples while the minimum decrement was observed in microwave cooked pulses. Microwave cooking was the suitable method for retaining the AOA in the pulses followed by pressure cooking. The maximum decrease in TPC was observed during microwave cooking in all pulses while least decrease was during pressure cooking followed by germination. It indicates that pressure cooking was the most suitable while microwave cooking was the least suitable for retention of TPC.

References

1. Tiwari BK, Gowen A, McKenna B. Introduction. In: Tiwari BK, Gowen A, McKenna B (ed) *Pulse Foods- Processing, Quality and Nutraceutical Applications*. USA: Academic Press publications; 2011, 2-3.

2. Patterson CA, Maskus H and Dupasquier. Pulse Crops for Health. *Cereal Food World.* 2009; 54: 108-112.
3. Percival M. Antioxidants. *Clinical Nutr Insights.* 1998; 10: 1-4.
4. Xu BJ, Yuan SH and Chang KC. Comparative analysis of phenolic composition, antioxidant capacity and colour of cool season legumes and other selected food legumes. *J Food Sci.* 2007; 72: S167-S177.
5. Narasinga Rao BS (2002). Pulses and legumes as functional foods. *Nutrition foundation of India.* Cited from www.nutritionfoundationofindia.res.in.
6. Amarakoon R. The effect of cooking on nutritive quality of selected legumes. M. Sc. Thesis. Tomas Bata University, Zlin, Czech Republic. 2009.
7. Ramakrishna V, Jhansi Rani P and Ramakrishna Rao P. Antinutritional Factors during germination in Indian Bean (*Dolichos lablab* L.) seeds. *World J Food Sci*. 2006; 1: 6-11.
8. Singleton VL, Orthofer R and Lamuela-Raventos R M. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteau reagent. *Methods Enzymol.* 1999; 299: 152-78.
9. Sreeramulu D, Kumar Reddy VC and Raghumath M. Antioxidant activity of cereals, millets, pulses and legumes commonly consumed in India. *Indian J Biochem Bio.* 2009; 46: 112-115.
10. Xu B and Chang SKC. Effect of soaking, boiling, and steaming on total phenolic content and antioxidant activities of cool season food legumes. *Food Chem.* 2008a; 110: 1-13.
11. Boateng J, Verghese M, Walker LT and Ogutu S. Effect of processing on antioxidants contents in selected dry beans (*Phaseolus spp.L.*). *Food Sci Technol-LEB.* 2008; 41*:* 1541-1547.
12. Dewanto V, Wu X and Liu RH. Processed sweet corn has higher antioxidant activity. *J Agric Food Chem.* 2002; 50: 4959-64.
13. Siddhuraja P and Becker K. The antioxidant activity and free radical-scavenging capacity of phenolics of raw and dry heated moth bean (*Vigna aconitifolia*) (Jacq.) Marechal seed extracts. *Food Chemistry.* 2006; 99:149-157.
14. Negi A, Boora P and Khetarpaul N. Effect of domestic processing and cooking methods on some antinutritional factors of moth beans. *J Dairying Foods and H.S.* 2008; 27: 114-119.
15. Xu B and Chang SKC. Total Phenolic Content and Antioxidant Properties of Eclipse Black Beans (*Phaseolus Vulgaris* L.) as Affected by Processing Methods. *J Food Sci.* 2008b; 73: H19-H27.