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Effect of cooking on bioactive compounds in pulses

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Abstract
Four commonly consumed pulses in the Telangana state, i.e., black gram, bengal gram, green gram and red gram, were selected to study the effect of open cooking and pressure cooking on biologically active compounds was studied. These were taken in dal forms with husk removed. Standard analysis procedures were followed for extraction and analysis of bioactive compounds. The results revealed that the percent change in total phenolic content in pulses upon open cooking was from -8.38 to 9.29, flavonoid content was from -42.8 to 58.5, DPPH radical scavenging activity was -6.96 to 13.8, and FRAP was from -17.2 to 3.21. The percent change in total phenolic content in pulses upon pressure cooking was between -3.2 to 7.6, total flavonoids between 22 to 40.3, DPPH radical scavenging activity -23.9 to 23.4, and FRAP between -13.3to 5.9. There was significant difference at 1% level was found among all pulses upon cooking.

Keywords: Pulses; bioactive compounds; open cooking and pressure cooking; FRAP; AOA; DPPH; phenols; flavonoids; antioxidants

Introduction

Pulses are essential constituent of daily diet in all the regions of India. Pulses are the major contributors of protein in our Indian diet. They can be a healthiest food of choice for a healthy lifestyle. They constitute an important source of several substances needed for good health, as phytochemicals and natural bioactive compounds. These grains are very high in nutrients; rich with protein, complex carbohydrates, soluble dietary fiber, and can be stored for months without losing their high nutritional value. Also, pulses are characterized by their nitrogen fixing properties contribute to increased soil fertility and have beneficial effects on the environment, but their benefits are often underestimated. At Sixty-eighth session, the United Nations General Assembly (20 December, 2013) announced that 2016 as the International Year of Pulses (IYP) and the Food and Agriculture Organization (FAO) of the United Nations was nominated for implementation of the International Year in collaboration with governments and different organizations.

Recent researches have associated the consumption of pulses with a decreased risk for a variety of chronic degenerative diseases such as cancer, obesity, diabetes and cardiovascular diseases [2, 7, 3]. Pulse grains are rich source of protein, dietary fibre, complex carbohydrates, resistant starch and a number of vitamins and minerals viz., folate, potassium, selenium and zinc. In addition to the macronutrients, pulses contain a wide variety of non-nutritive bioactive components such as enzyme inhibitors, phytic acid, lectins, phytosterols, phenolic compounds and saponins[4]. These nonnutritive bio-active compounds earlier considered as anti-nutrients because of their activity to reduce protein digestibility [5] and mineral bioavailability have recently been shown to have health protective effects [6]. Phytic acid exhibits antioxidant activity and protects DNA damage [8], phenolic com- pounds have antioxidant and other important physiological and biological properties [12], saponins have hypocho- lesterolaemic effect and anti-cancer activity [9]. This re- view seeks to discuss and document the potential benefits to human health derived from the consumption of pulse grains and examine the bioactivity of pulse lectins, phytic acid, isoflavones, phytosterols and saponins, and their role in the prevention of various chronic diseases.

The pulses are cooked and consumed for easy digestibility and palatability. Cooking not only enhances digestibility, but also removes or inactivates the anti-nutritional factors present in them and improves the bioavailability of beneficial nutrients. Different methods are followed for cooking these pulses. The common method of cooking is open and pressure cooking.

As they constitute major part of our daily diet, the study was undertaken to study the effect of different methods of cooking on bioactive compounds in pulses.

Materials and Methods

Four most commonly consumed pulses in Telangana State, i.e. green gram, red gram, bengal gram, and black gram. These were collected from the local market all taken in dal forms with husk removed. The procured pulses were open cooked and pressure cooked using normal tap water. Bioactive compounds were analysed in raw pulses as well as cooked pulses (both pressure and open cooked).

Reagents used were methanol, 6N hydrochloric acid, Whatman No. 1 filter paper, distilled water, Gallic acid (GA), Folin-Ciocalteu reagent, sodium carbonate (7.5%), Rutin standard solution (10%), sodium nitrite (5 gm%), aluminium chloride (10 g%), sodium hydroxide (1N), Trolox standard solution (10 mg%):, acetate buffer (0.2M) (pH 3.6), hydrochloric acid (400 mM), TPTZ (2, 4, 6-tris (2-pyridyl)-s-triazine) (10 mM), ferric chloride (hexahydrate) (20 mM) (freshly prepared), FRAP working reagent (freshly prepared), Trolox standard solution (10 mg%), DPPH solution, and methanol.

Extraction of raw and cooked samples was done using 80% methanol acidified to pH 2.0 with 6N hydrochloric acid. Total phenolic content, flavonoids, and antioxidant activity was estimated in these extracts.

Standard analysis procedures were followed for analysis for bioactive compounds in pulses, i.e. total phenolic content was analysed by Singleton *et al* 1999 method [10], total flavonoids by Zhishen *et al*., 1999 method [13]. DPPH Radical-Scavenging Activity by Tadhani *et al*. 2007 [11] method and Ferric reducing antioxidant power (FRAP) was determined according to Benzie and Strain 1999 methods [1].

Results and Discussion

Total phenols in pulses

The total phenolic content of raw extracts of pulses ranged from 40.44(±1.66) mg GAE/100g to 95.7(±1.09) mg GAE/100 g. Their order was as follows: Bengal gram dal > red gram dal> black gram dal > green gram dal. Among the pulses studied, two samples (black gram dal and bengal gram dal) showed significant loss in phenolic compounds upon cooking. About -4.5 to -8.38% low TPC was observed after open cooking and -3.2% low TPC was observed upon pressure cooking in our study. The mean values of different pulses as well as percent change on cooking, i.e. pressure cooking and open cooking, is given in table 1 and fig 1. Mixed effects were noticed in TPC upon cooking. -8.38 to 9.29% change can be observed in the open cooked extracts as compared to control and -3.2 to 7.6% change in TPC can be observed in the pressure cooked extracts as compared to the control. Though there was increase or loss in TPC on open cooking and pressure cooking of pulses, but the difference is very less and is negligible. The% increase in TPC was more observed upon pressure cooking compared to open cooking.

Table 1: Total Phenol Content of Pulses and Percent Change on Cooking as Compared to Raw (mg GAE/100g)

S. No	Samples (Scientific name along with local English name*)	Raw	Open cooking	% change	Pressure cooking	% change
1.	Blackgram (Phaseolus mungo Roxb	63.49(±2.62)	58.17(±1.63)	-8.38	61.43(±1.64)	-3.2
2.	Greengram (Phaseolus aureus Roxb)	40.44(±1.66)	43.6(±0.53)	7.8	42.6(±1.15)	5.34
3.	Redgram (Cajanuscajan)	73.2(±2.89)	79.93(±0.47)	9.29	77.9(±0.56)	6.42
4.	Bengal gram (Ciceraritinum)	95.7(±1.09)	91.43(±1.09)	-4.5	103(±2.7)	7.6

Values are mean ± standard deviation of three observations

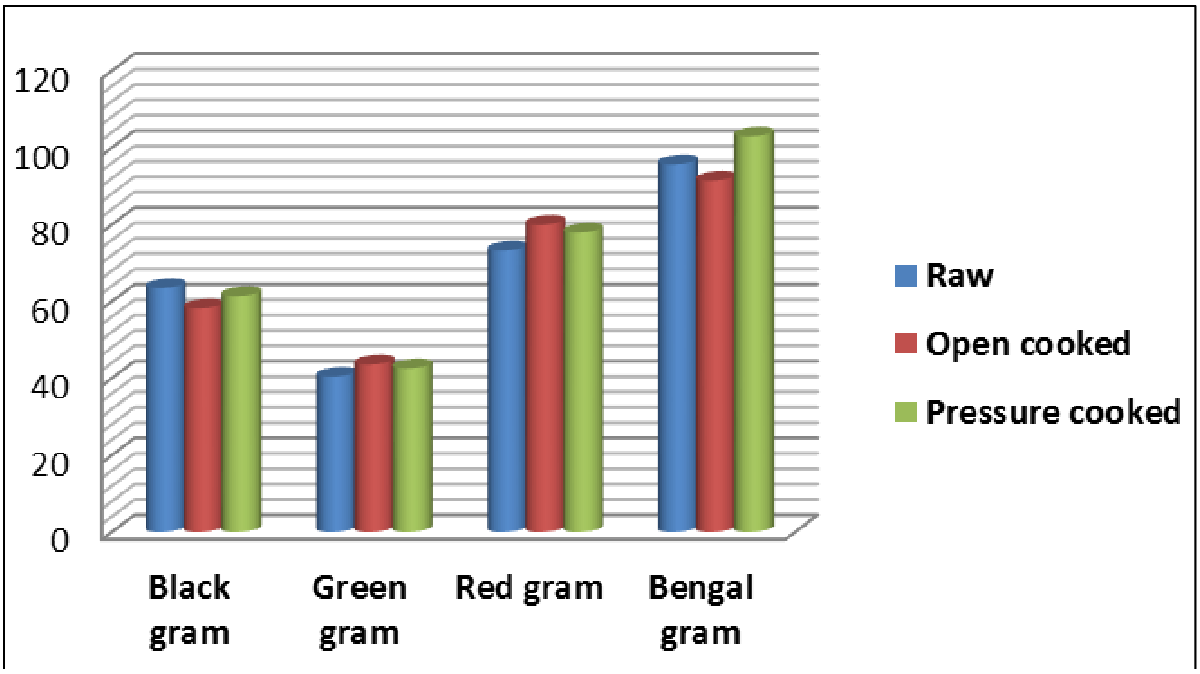

Fig 1: Effect cooking on total phenol content in pulses

Flavonoids in pulses

In the raw pulse extracts, pulses scored 49.02(±1.04) to 108.13(±1.53) mg RE/100g of flavonoid content. They can be ranked as, red gram dal > bengal gram dal > black gram dal > green gram dal. In open cooked extracts, pulses scored 28.32(±1.32) to 65.6(±3.25) mg RE/100g and in pressure cooked extracts, the observed range was 31.43(±1.12) to 76.15(±1.63) mg RE/100g. There was increase in flavonoids observed upon cooking, both open and pressure, whereas there was loss observed in green gram dal upon open cooking, which was about 42.8%. The flavonoid content of cooked extracts was significantly higher than the raw. The percent increase in flavonoids upon open cooking was 0.91 to 55.85% and percent decrease was -42.8%. The sequence of legumes based on their percent increase upon open cooking was black gram dal > red gram dal > bengal gram dal. Pressure cooking also caused recovery of flavonoids and higher recovery was observed in black gram dal. Ranking of pulses based on higher recovery of flavonoid upon pressure cooking is as follows: black gram dal > green gram dal > red gram dal > bengal gram dal. The mean flavonoid content of pulses as well as percent change on cooking, i.e. pressure cooking and open cooking, is given in table 2 and fig 2.

Table 2: Total Flavonoids Content of Pulses and Percent Change on Cooking as Compared to Raw (mg RE/100 g)

S. No	Samples (Scientific name along with local English name*)	Raw	Open cooking	% change	Pressure cooking	% change
1.	Blackgram (Phaseolus mungo Roxb)	86.7(±1.25)	49.32(±1.43)	55.85	51.79(±1.88)	40.3
2.	Greengram (Phaseolus aureus Roxb)	49.02(±1.04)	28.32(±1.32)	-42.8	31.43(±1.12)	35.9
3.	Redgram (Cajanus cajan)	108.13(±1.53)	64.72(±2.43)	33.65	76.15(±1.63)	29.6
4.	Bengal gram (Cicer aritinum)	92.8(±2.43)	65.6(±3.25)	0.91	72.4(±1.86)	22

Values are mean ± standard deviation of three observations

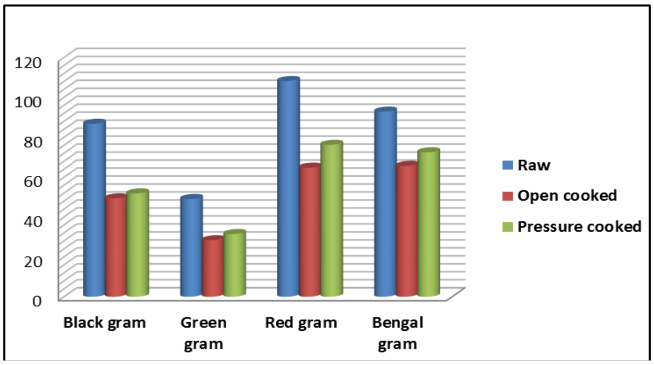

Fig 2: Effect cooking on flavonoid content in pulses

Antioxidant Activity

FRAP (Ferric Reducing Antioxidant Power)

Ferric reducing antioxidant power in the control extracts of legume samples ranged from 63.2(±1.99) to 120.62(±1.86) mg TE/100g. They can be ranked based on AOA as, black gram dal > bengal gram dal > red gram dal > green gram dal. FRAP of black gram dal and red gram dal fell by -17.2 and -2.45% respectively upon open cooking and -13.3 and -0.36% respectively upon pressure cooking. The difference in loss is negligible when compared the two methods of cooking. Increase in FRAP of green gram dal and bengal gram dal was observed upon cooking and the increase was 3.21 and 2.14% respectively upon open cooking and 5.9 and 4.54% respectively upon pressure cooking. Whether it is increase or decrease in FRAP, there was not much difference observed when compared AOA in cooked extracts. The mean AOA in pulses as well as percent change on cooking, i.e. pressure cooking and open cooking, is given in table 3 and fig 3.

Table 3: Antioxidant activity in pulses (by FRAP) and Percent Change on Cooking as Compared to Raw (mg TE/100g)

S. No	Samples (Scientific name along with local English name*)	Raw	Open cooking	% change	Pressure cooking	% change
1.	Blackgram (Phaseolus mungo Roxb)	120.62(±1.86)	99.86(±2.4)	-17.2	104.62(±0.91	-13.3
2.	Greengram (Phaseolus aureus Roxb)	63.2(±1.99)	65.23(±1.83)	3.21	66.91(±0.87)	5.9
3.	Redgram (Cajanus cajan)	81.62(±1.26)	79.62(±1.36)	-2.45	81.32(±2.1)	-0.36
4.	Bengal gram (Cicer aritinum)	83.18(±0.21)	84.96(±1.55)	2.14	86.96(±1.41)	4.54

Values are mean ± standard deviation of three observations

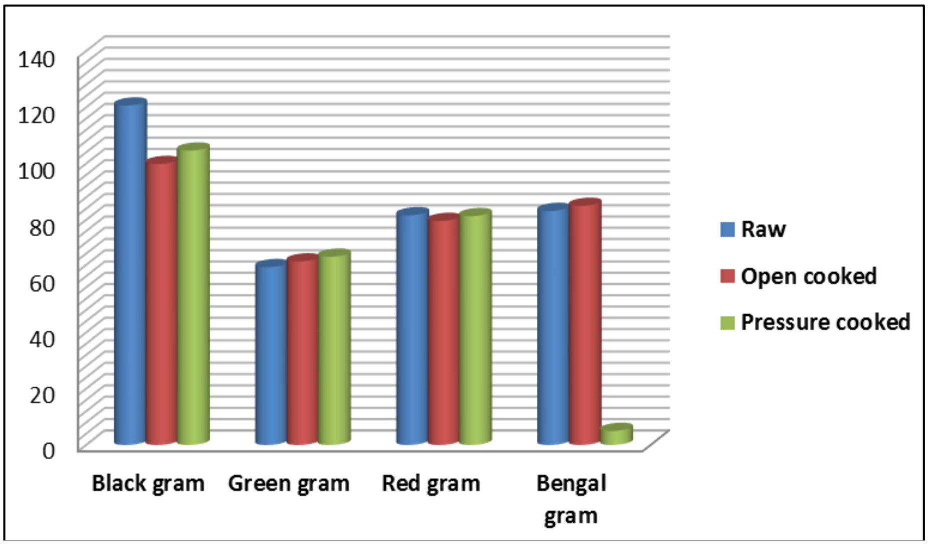

Fig 3: Effect cooking on AOA (by FRAP) in pulses

DPPH radical scavenging ability

Pulses were analyzed for raw, open cooked, and pressure cooked for AOA by DPPH radical scavenging activity and the results are depicted in table 4, fig 4. From the above table, it is observed that highest AOA was in Bengal gram (45.23 mg TE/100 g) followed by red gram (43.7 mg TE/100 g) compared to other pulses and the least values were found in green gram (23.97 mg TE/100 g). DPPH radical scavenging activity of legume samples varied from 23.97(±2.18) to 43.7 (±0.90) mg TE/100g in the raw extracts. They followed the ranking: bengal gram > red gram > black gram > green gram. There was an increase in AOA upon cooking in all pulses with the range of 22.3 mg TE/100g to 49.73 mg TE/100 g in open cooked pulses and 18.24 mg TE/100 g and 47.44 mg TE/100 g in pressure cooked pulses. DPPHRSA was diminished on open cooking in green gram (-6.96%) and pressure cooking (-23.9%). There was also diminished DPPHRSA observed upon pressure cooking of black gram dhal and percent decrease was -9.43. There was increased AOA observed upon open cooking and pressure cooking of the rest of the pulses analysed. They can be ranked based on the percent increase of AOA upon open cooking as red gram > black gram > bengal gram and upon pressure cooking as red gram > bengal gram. The percent increase was more observed in red gram upon pressure cooking. The mean values of different pulses as well as percent change on cooking, i.e. pressure cooking and open cooking, is given in table 4 and fig 4.

Table 4: Antioxidant activity in pulses (by DPPH) and Percent Change on Cooking as Compared to Raw

S. No	Samples (Scientific Name Along With Local English Name*)	Raw	Open Cooking	% Change	Pressure Cooking	% Change
1.	Blackgram (Phaseolus Mungo Roxb)	35.1 (±1.51)	36.97(±1.65)	5.33	31.79(±1.4)	-9.43
2.	Greengram (Phaseolus Aureus Roxb)	23.97 (±2.18)	22.3(±2.2)	-6.96	18.24(±0.89)	-23.9
3.	Redgram (Cajanus Cajan)	43.7 (±0.90)	49.73(±1.15)	13.8	56.54(±1.52)	23.4
4.	Bengal Gram (Cicer Aritinum)	45.23 (±2.65)	45.6(±0.45)	0.81	47.44(±1.58)	4.9

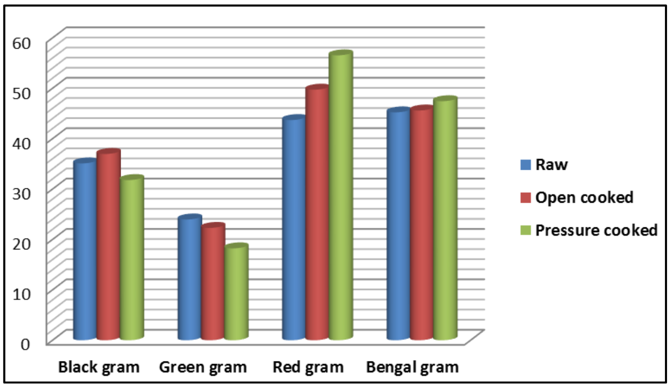

Fig 4: Effect cooking on AOA (byDPPH) in pulses

Summary and Conclusion

Four commonly consumed pulses (black gram, bengal gram, green gram and red gram) in Telangana state were collected from the local market. They were subjected to open cooking and pressure cooking, the most common methods cooking, and bioactive compounds were analysed in raw as well as cooked ones. The results revealed pulses contain significant amounts of phenolics, flavonoids, and possess antioxidant activity. Among the pulses studied, bengal gram dal showed high amounts of phenols, followed by red gram, black gram and green gram. High flavonoid content was found in red gram dal, followed by bengal gram dal, black gram dal, and green gram dal. Antioxidant activity (FRAP) was noted to be high in black gram dal followed by bengal gram dal, then red gram and green gram dal. DPPHRSA was found to be high in bengal gram followed by red gram dal, black gram dal and then green gram dal. Mixed results were observed upon cooking. Increase in total phenol content was observed in green gram dal and red gram dal upon pressure and open cooking, whereas loss was found in black gram dal. Increase in flavonoid content was observed upon cooking in all pulses, except in green gram. Ferric reducing antioxidant power was found to be more in cooked green gram and bengal gram than the raw, whereas it was found to be less in cooked forms and more in raw forms in black gram dal and red gram dal. DDPHRSA was found to be increased upon cooking in case of red gram dal and bengal gram dal (both upon open and pressure cooking), where was decreased upon pressure cooking in black gram dal and both pressure cooking and open cooking in black gram dal. From the study we can say that pressure cooking could be the suitable processing method and can be recommended for the consumption of these pulses in order to increase the dietary intake of health beneficial bioactive compounds.

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