Journal of Food Legumes
38(2): 246-254, 2025
DOI: 10.53550/jfl.v38.i2.266

Research Paper

Chemical composition of 20 Brazilian desi and kabuli chickpea genotypes: the contributions of type and seed coats to antioxidant properties

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Received: *December 11, 2024*
Accepted: *January 27, 2025*

ABSTRACT

This study analysed twenty Brazilian desi and kabuli chickpea cultivars for moisture, ash, lipid, protein, trypsin inhibition, and total phenolic and flavonoid content. Antioxidant activity was assessed using ABTS+ and DPPH assays. Desi chickpea seed coats, which are darker in color, correlated with higher phenolic and flavonoid contents, resulting in greater antioxidant activity. No clear differences in moisture, lipid, protein, ash, or trypsin inhibition were found between the desi and kabuli types. The chickpeas exhibited 8.08–9.05% moisture, 2.16–3.10% ash, 4.52–6.78% lipids, 16.69–23.78% protein, and 58.27–63.48% carbohydrates. All samples showed potential as protein sources. Consuming chickpeas with seed coats, particularly desi varieties, may offer enhanced antioxidant benefits. This highlights the health-promoting potential of incorporating seed coats into food preparations. Additionally, the study underscores the potential of these Brazilian cultivars as sustainable, nutrient-dense sources with bioactive compounds.

Key words: *Cicer arietinum*, Pulses, Legumes, Total phenolics, Flavonoids, Seed coat

INTRODUCTION

The consumption of legumes is increasingly recognized in scientific literature as a vital contributor to human health (Faridy *et al*. 2020). Numerous studies have established associations between the various components of legumes and their health benefits, with particular emphasis on their protein content and bioactive compounds, including phenolics (Begum *et al*. 2023, Bochenek *et al*. 2023). Notably, Fadnes *et al*. (2022) demonstrated that consuming 100 grams of raw legumes or 200 grams of cooked legumes—approximately equivalent to one large cup of drained, cooked legumes—can extend the healthy lifespan of adults by one year, underscoring the potential of legumes in promoting longevity. Additionally, legumes serve as important dietary sources of protein (Zargarzadeh *et al*. 2023) and are recognized for their environmental benefits, as they exhibit lower climate impact and are considered sustainable food sources (Yani *et al*. 2023).

Among legumes, chickpeas remain underutilized in Brazil. However, the expanding cultivation of chickpeas within the country and the diversification of available cultivars present a significant opportunity to enhance their consumption. Similar to other legumes, chickpeas are associated with numerous health benefits. A notable advantage of chickpea consumption is their reduced likelihood of causing flatulence compared to other legumes, such as beans (Fleming 1981). Flatulence, a common deterrent to legume consumption among adults (Doma *et al*. 2019), can be mitigated by promoting chickpeas, thereby encouraging greater legume intake.

Although chickpea preparation methods often involve the removal of seed coats, which may reduce their nutritional value (Kaur and Prasad 2021), the importance of these seed coats should not be underestimated. Zhong *et al*. (2018) emphasize that chickpea seed coats are rich sources of dietary fiber, minerals, and health-promoting phytochemicals. Among phytochemicals, many phenolic compounds have been highlighted for their roles as antioxidants, antihypertensives, hypocholesterolemic, and anticancer (Faridy *et al*. 2020). Antioxidant activity is one of the most recognized functions among the various phenolic compounds identified in grains (Bochenek *et al*. 2023).

Research has also highlighted considerable variability among chickpea cultivars and the influence of growing conditions on their composition and functionality (Mathew and Shakappa 2024). This study aims to investigate recently cultivated chickpea varieties in Brazil, focusing on their chemical composition and antioxidant activity, while evaluating the role of seed coats in modulating these parameters.

MATERIALS AND METHODS

Materials

Brazilian chickpea samples were provided by AgroGarbanzo Produção Agrícola LTDA (Cristalina, GO), comprising 14 kabuli and 6 desi seed types, as shown in Figure 1.

Seed color and weight

The initial characterization of the chickpeas included weighing 100 randomly selected seeds, as well as the seed coats, which were manually removed to estimate the proportion of coat weight relative to the total seed weight. The color of whole seeds was analyzed at three random points using a Konica Minolta colorimeter (CR400, Minolta Co, Japan) using the color parameters: L* = lightness (100) and darkness (0), a = green (-) and red (+) coordinates, b = blue (-) and yellow (+) coordinates.

Flour preparation

For subsequent analyses, both the whole seeds and their separated coats were analyzed. Cleaned seeds were ground using a Pulverisette 14 mill and passed through an 80-mesh sieve. For seed coat analysis, the manually separated coats were equally ground and stored for further analysis.

Chemical composition

The moisture, fat, protein,and ash content of chickpea samples were determined according to AOAC methods (1995). Nitrogen content was measured by the Kjeldahl method, and protein content was calculated as nitrogen × 6.25. Total carbohydrate content was estimated by difference.

Trypsin inhibitors

Trypsin inhibitor activity was assessed as described by Kakade *et al*. (1974), using BAPNA as the substrate, and results were expressed as trypsin inhibition units (TIU).

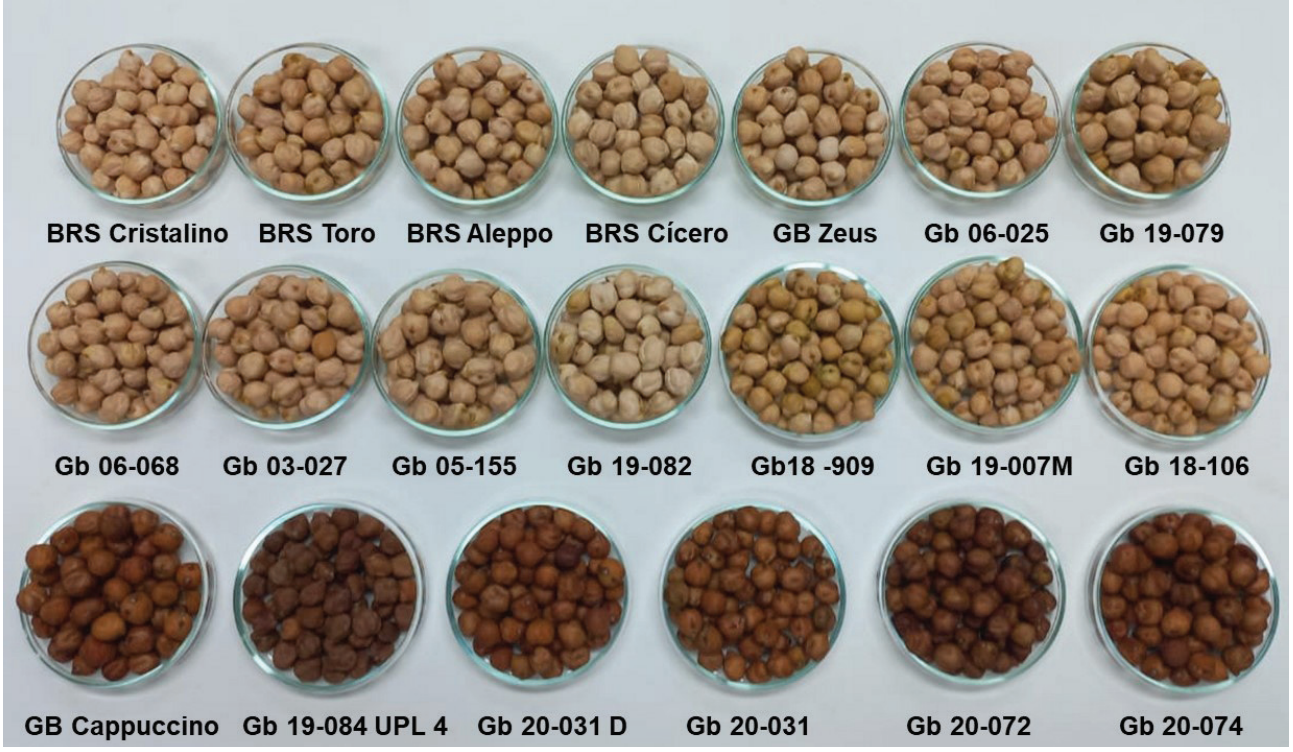

Fig. 1. Kabuli (cream color) and desi (brown color) Brazilian chickpea genotypes

Extractions

Extracts were prepared to determine total phenolic content, total flavonoid content, and antioxidant activity, following the method of Segev et al. (2010). Whole seed and seed coat samples were extracted with a 50% acetone solution at a 1:20 (w/v) flour-to-acetone ratio. Samples were shaken for 30 minutes, then centrifuged at 7,000 *g* for 30 minutes at 5°C using a refrigerated centrifuge (FANEN Excelsa 4–Model 280R). The extraction was repeated twice with a 1:10 (w/v) flour-to-acetone ratio, and supernatants were pooled. To calculate the contribution of seed coats to the grain data, the results were proportionally estimated, considering the outcomes for the whole seeds and coats and their respective proportional weights in the seeds.

Total phenolic content

Total phenolic content was determined spectrophotometrically using the Folin-Ciocalteu reagent, following the method of Singleton and Rossi (1965) with modifications from Boateng *et al.* (2008). A gallic acid standard curve (0–16 µg/mL) was used, and results were expressed as gallic acid equivalents per gram of sample.

Total flavonoid content

Flavonoid content was measured using the aluminum chloride spectrophotometric assay as described by Boateng *et al.* (2008). A catechin standard curve (0–50 µg/mL) was prepared, and results were expressed as µg catechin equivalents per gram of sample.

Potential antioxidant activity

The ABTS+ radical was generated by incubating 7 mmol/L ABTS (2,2′-Azino-Bis(3-Ethylbenzothiazoline-6-Sulfonic Acid) Diammonium Salt)with 2.4 mmol/L potassium persulfate in the dark for 16 hours, as described by Shalaby and Shanab (2013). The ABTS solution was diluted with water to an absorbance of 0.700 at 734 nm. To 250 µL of the sample extract, 750 µL of ABTS solution was added, and absorbance was measured after 60 minutes in the dark. DPPH radical-scavenging activity was assessed following the method of Brand-Williams *et al.* (1995) with modifications. Briefly, 1 mL of the sample extract was added to 4 mL of an 80% ethanol DPPH (2, 2-diphenyl-1-picrylhydrazyl) solution, and absorbance was measured at 517 nm. A standard curve using TROLOX (6-hydroxy-2,5,7,8 – tetramethylchroman-2-carboxylic acid) was generated as the reference, and results were expressed as µmol TROLOX equivalents per gram of sample for both assays.

Statistical analyses

The Shapiro-Wilk test was used to assess normality, Pearson's correlation test was applied to examine relationships, and ANOVA, followed by Tukey's post hoc test, was conducted for mean comparisons. A significance level of $p<0.05$ was used. Data were tabulated using Excel(R) and analyzed with JASP software (version 0.19.1, 2023).

RESULTS AND DISCUSSION

Contrary to previous findings, our study revealed that desi chickpea seeds were not consistently smaller than kabuli seeds, despite typical differences in size and color between the two types. As shown in Figure 1, both types of seeds appear visually similar. This observation is further supported by seed weight data presented in Table 1. The primary distinction between the seed types was in the proportion of seed coat weight relative to total seed weight, with kabuli seeds ranging from 4.06% to 5.42% and desi seeds from 7.44% to 10.47%, as shown in Table 1.

The present result aligns with previous findings. Hawtin and Singh (1979) also reported higher seed coat percentages in desi seeds compared to kabuli seeds, noting that the most significant differences between these types are in fiber and seed coat content. Data in Figure 2 similarly indicate no distinct differentiation between kabuli and desi seeds regarding moisture, ash, lipid, and protein content. While differences in protein levels among the seeds are noticeable, these cannot be attributed solely to the desi or kabuli type. Regarding protein content, all samples demonstrated potential as protein sources, with values ranging from 16.69% to 23.73%. Mathew and Shakappa (2024) found similar results, reporting protein levels between 16.09–26.22 g/100 g in a study of 21 desi and 10 kabuli samples.

Protease inhibitors, or trypsin inhibitors, are significant components of legume protein fractions. Table 2 presents the trypsin inhibitor content in the seeds. All samples showed values within expected ranges. Guillamón *et al.* (2008) also found values between 15–19 TIU/mg of sample. While desi seeds tended to show higher trypsin inhibition activities, it cannot be definitively concluded as a characteristic of this type since high values were also observed

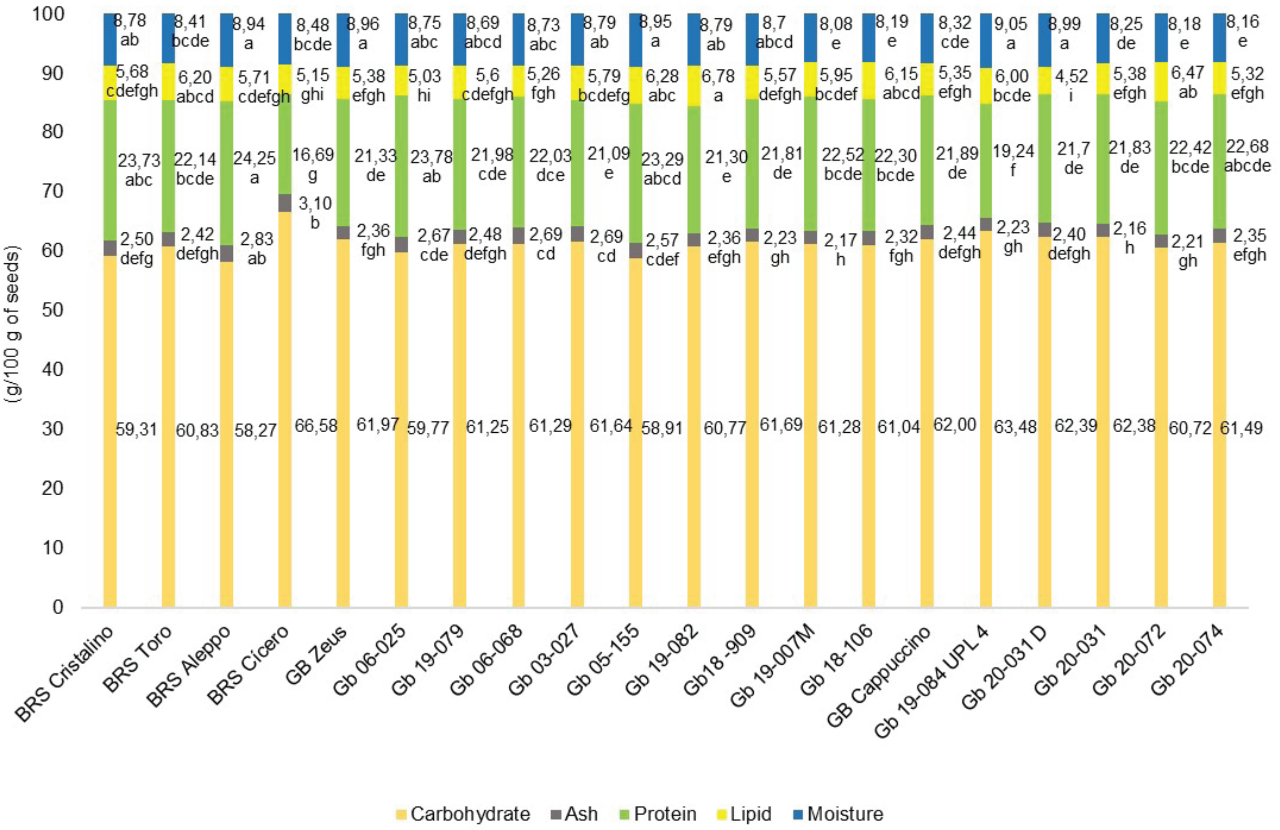

Fig. 2. Chemical composition of chickpea Brazilian genotypes. Results are expressed as mean ± standard deviation of three determinations. Different letters in the same component results express significant differences between samples ($p < 0.05$).

Table 1. Characteristics of Brazilian desi and kabuli chickpea genotypes

Sample	**Type**	**Seed coat appearance**	**100-seed weight (g)**	**Seed coat (%)**	**Color measurement#**		
					L	**a**	**b**
Kabuli							
BRS Cristalino*	Kabuli	Cream	39.40	5.42	59.70	+13.26	+27.56
BRS Toro*	Kabuli	Cream	54.14	4.87	61.76	+12.33	+28.86
BRS Aleppo*	Kabuli	Cream	43.53	4.47	58.23	+11.93	+24.40
BRS Cícero*	Kabuli	Cream	45.18	5.24	57.36	+10.13	+22.53
GB Zeus*	Kabuli	Cream	38.85	4.97	58.66	+14.90	+29.03
Gb 06-025§	Kabuli	Cream	38.89	4.06	58.40	+11.63	+24.30
Gb 19-079§	Kabuli	Cream	53.41	4.54	56.90	+11.66	+27.63
Gb 06-068§	Kabuli	Cream	37.76	4.11	57.20	+13.96	+27.86
Gb 03-027§	Kabuli	Cream	50.13	4.97	61.96	+13.20	+27.76
Gb 05-155§	Kabuli	Cream	51.47	4.60	53.16	+11.33	+23.70
Gb 19-082§	Kabuli	Cream	53.72	4.54	55.36	+9.53	+23.20
Gb18 -909§	Kabuli	Cream	36.26	4.96	52.86	+10.70	+27.96
Gb 19-007M§	Kabuli	Cream	32.94	4.44	56.93	+13.30	+28.03
Gb 18-106§	Kabuli	Cream	34.59	4.73	54.66	+12.73	+25.93
Desi							
GB Cappuccino*	Desi	Brown	51.39	9.21	38.66	+18.90	+25.80
Gb 19-084 UPL 4§	Desi	Brown	40.99	10.47	31.66	+13.46	+18.13
Gb 20-031 D§	Desi	Brown	41.05	7.91	40.56	+22.36	+27.60
Gb 20-031§	Desi	Brown	42.34	8.07	39.10	+20.00	+26.33
Gb 20-072§	Desi	Brown	43.51	7.44	29.13	+16.53	+19.90
Gb 20-074§	Desi	Brown	50.89	8.35	33.86	+19.13	+23.76

* Released cultivar, as registered in the Ministry of Agriculture and Livestock, Brazil (https://sistemas.agricultura.gov.br/snpc/cultivarweb/cultivares_registradas.php). §Brazilian new lines.

Color parameters: L* = lightness (100) and darkness (0), a = green (-) and red (+) coordinates, b = blue (-) and yellow (+) coordinates.

in some kabuli samples, with the highest TIU per mg protein found in the kabuli sample BRS Cícero (106.49 TIU/mg of protein) (Table 2).

While trypsin inhibitors are generally considered components of legume protein fractions, attributing all detected trypsin inhibition solely to Bowman-Birk or Kunitz inhibitors can be challenging due to the potential interaction of phenolic compounds with proteins, which may inhibit enzymatic activities (Sreerama *et al*.2010). Interestingly, despite the higher phenolic content in desi seeds (Figure 3), this group did not exhibit superior inhibition activities, and no statistically significant correlation was found between trypsin inhibitor units (TIU) and phenolic content in the samples. This finding is notable, as the literature increasingly suggests that the presence of Bowman-Birk inhibitors may offer health benefits (Gitlin-Domagalska *et al*. 2020). For example, Cid-Gallegos *et al*. (2022) observed that while these inhibitors are traditionally considered antinutritional, studies indicate that, at certain consumption levels, they may promote blood pressure reduction, coronary vasodilation, and the prevention of autoimmune diseases and inflammatory processes. They may also contribute to the treatment of colon, prostate, and breast cancer.

Among their various functions, phenolic compounds serve as potent antioxidants. In this study, seeds with higher phenolic and flavonoid contents exhibited greater antioxidant activities in both the seed coats (Table 3) and the whole seeds (Figures 3–5). The data indicate that grains with colored seed coats have higher levels of antioxidant

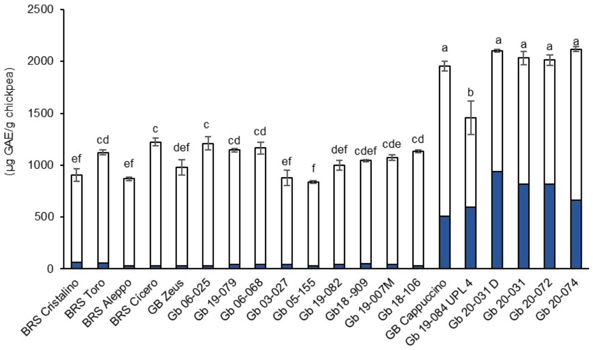

Fig. 3. Total phenolics of chickpea Brazilian genotypes. Colored bars represent the phenolic content derived from the seed coats present in the whole seeds.Results are expressed as mean ± standard deviation (error bars) of three determinations. GAE: gallic acid equivalent. Different letters in the results express significant differences ($p < 0.05$).

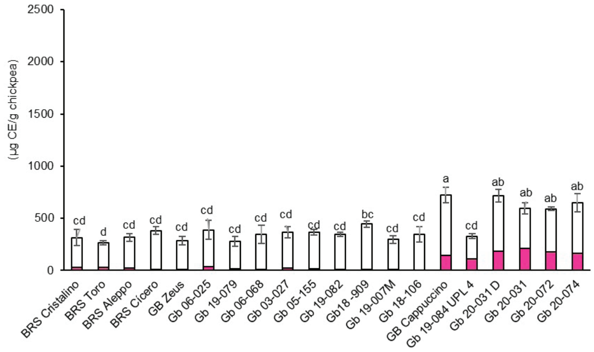

Fig. 4. Total flavonoids of chickpea Brazilian genotypes. Colored bars represent the flavonoid content derived from the seed coats present in the whole seeds.Results are expressed as mean ± standard deviation (error bars) of three determinations. CE: catechin equivalents. Different letters in the results express significant differences ($p < 0.05$).

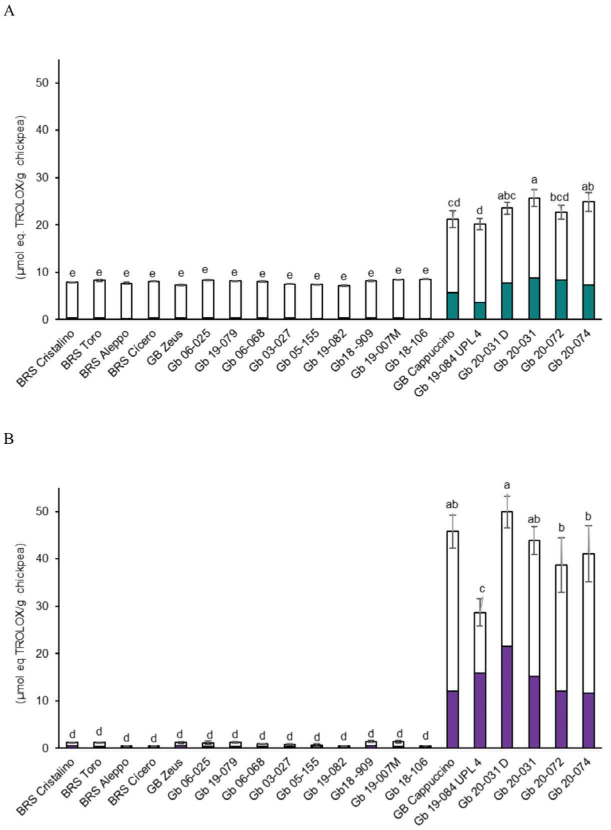

Fig. 5. Antioxidant activity of chickpea Brazilian genotypes, using ABTS (A) and DPPH (B) determination. Colored bars represent the values corresponding to those produced by the seed coats present in the whole seeds. Results are expressed as mean ± standard deviation (error bars) of three determinations. Different letters in the results indicate significant differences ($p < 0.05$).

Table 2. Trypsin inhibition units (TIU) of Brazilian desi and kabuli chickpea genotypes

Chickpea	**Trypsin inhibition**	
	(TIU/mg of seed)	**(TIU/mg of seed protein)**
Kabuli		
BRS Cristalino	15.01 ± 2.31 efg	64.93 ± 1.01 fgh
BRS Toro	13.71 ± 1.47 g	63.49 ± 6.81 gh
BRS Aleppo	13.93 ± 6.88 g	58.81 ± 2.90 h
BRS Cícero	17.12 ± 3.38 abc	106.48 ± 2.10 a
GB Zeus	16.81 ± 4.62 abc	80.32 ± 2.21 cd
Gb 06-025	16.07 ± 6.23 bcde	69.24 ± 2.68 efg
Gb 19-079	16.27 ± 1.28 abcde	76.02 ± 6.01 cde
Gb 06-068	15.22 ± 7.25 defg	71.08 ± 3.38 ef
Gb 03-027	14.11 ± 5.77 g	68.97 ± 2.82 efg
Gb 05-155	15.70 ± 2.14 cdef	69.31 ± 9.47 efg
Gb 19-082	17.22 ± 3.43 abc	83.18 ± 1.65 c
Gb18 -909	16.66 ± 3.08 abcd	78.53 ± 1.45 cd
Gb 19-007M	14.19 ± 3.16 fg	64.82 ± 1.44 fgh
Gb 18-106	16.27 ± 3.41 abcde	74.97 ± 1.57 de
Desi		
GB Cappuccino	17.46 ± 4.44 ab	82.14 ± 2.09 cd
Gb 19-084 UPL 4	17.75 ± 5.28 a	95.30 ± 2.84 b
Gb 20-031 D	16.66 ± 1.04 abcd	78.96 ± 4.95 cd
Gb 20-031	17.03 ± 1.98 abc	80.21 ± 9.34 cd
Gb 20-072	16.55 ± 2.15 abcde	75.95 ± 9.88 cde
Gb 20-074	15.24 ± 8.48 defg	68.88 ± 3.83 efg

Values are means ± SD, n = 3. Means accompanied by the different letters in the same column indicate significant difference between samples ($p < 0.05$).

components, as well as greater activity detected through both DPPH and ABTS assays (Figures 3–5). Based on the total phenolic and flavonoid contents and antioxidant activities detected in the seed coats separately (Table 3) and the percentage of seed coat mass in each seed (data shown in Table 1), it was possible to estimate the contribution of seed coats to the overall results observed for the whole seeds. This is illustrated in Figures 3–5 through the representation of the colored bars. These findings underscore the significance of seed coat components in the biofunctional properties of the chickpea cultivars studied here.

However, results from Figures 3 and 4 suggest that quantitative levels of these compounds alone do not fully explain the significant differences observed, particularly in the DPPH assay (Fig. 5b). Beyond total amounts, the specific phenolic profiles of each sample are likely relevant, as research has shown compositional differences in phenolics between seed coats and cotyledons, and between desi and kabuli chickpea coats (Brun *et al*. 2024).

Pal *et al.* (2023) demonstrated distinct differences between the seed coats of desi and kabuli chickpeas, highlighting a greater deposition of proanthocyanidins in the endothelial layers of desi seed coats compared to kabuli seed coats. Furthermore, they detected the presence of anthocyanin precursors—cyanidin, delphinidin, pelargonidin, petunidin, peonidin, and malvidin—in desi seed coats, which were absent in kabuli seed coats. These compounds are recognized both as potent antioxidants and as contributors to plant pigmentation (Noda *et al*. 2002).

Table 4 further underscores this observation, presenting antioxidant activity normalized per unit of total phenolics or flavonoids. Higher indices were noted among desi seeds, particularly in DPPH assays and seed coats, suggesting that both quantitative and qualitative differences in phenolic profiles contribute to the results. The FLAOXI index was particularly prominent for desi seed coats.

Pearson's correlation analysis revealed significant associations between phenolic content and antioxidant activity. Strong correlations were observed between total phenolics in seeds and ABTS activity (R=0.8662, *p=0.0057*), and between phenolics in seed coats and DPPH activity (R=0.8632, *p=0.0009*). The strongest correlation was identified between phenolics in coats and ABTS activity in coats (R=0.9203, *p=0.0009*). For flavonoids in seeds, weaker correlations with antioxidant activities were observed, with the strongest association being between seed coat flavonoids and DPPH activity in seeds (R=0.7053, *p=0.0005*).

Correlation testing between color measurements (Table 1) and antioxidant activity showed an inverse relationship between "L" values and ABTS activity in seeds (R= -0.6662, *p=0.0013*), indicating that darker seeds exhibit higher antioxidant potential. Additionally, "L" values inversely correlated with phenolic content in seeds (R = -0.6436, *p=0.022*). A positive correlation was found between "a" values and DPPH activity in seeds and coats (R= 0.7368, p=*0.0002*, and R=0.7684, *p=0.0001*, respectively), suggesting that redder seeds tend to have higher antioxidant activity. This observation aligns with the potential presence of anthocyanins, such as delphinidin, which impart purple coloration (Husain *et al.* 2022).

Beyond antioxidant activities, phenolic

Table 3. Total phenolics, flavonoids, and antioxidant activity of the seed coat of desi and kabuli chickpea genotypes

Chickpea	Total Phenolics (µg GAE/g of seed coat)	Total Flavonoids (µg CE/g of seed coat)	Antioxidant activity (µmol TROLOX equivalents/g of seed coat)	
			ABTS	DPPH
Kabuli				
BRS Cristalino	1117.52 ± 32.59 d	475.02 ± 71.86 cd	7.05 ± 0.25 d	9.52 ± 0.15 e
BRS Toro	1174.48 ± 17.55 d	574.74 ± 44.21 cd	7.07 ± 0.23 d	8.49 ± 0.11 e
BRS Aleppo	683.22 ± 55.23 d	504.97 ± 68.06 cd	6.02 ± 0.07 d	8.07 ± 0.14 e
BRS Cícero	560.31 ± 127.23 d	205.92 ± 67.40 cd	5.88 ± 0.30 d	6.71 ± 0.07 e
GB Zeus	637.26 ± 30.64 d	148.52 ± 68.06 d	5.64 ± 0.29 d	9.06 ± 0.21 e
Gb 06-025	807.26 ± 44.09 d	539.56 ± 41.98 cd	6.92 ± 0.13 d	8.50 ± 0.23 e
Gb 19-079	962.71 ± 26.64 d	201.57 ± 34.93 cd	8.67 ± 0.29 cd	9.03 ± 0.38 e
Gb 06-068	1101.46 ± 67.59 d	283.76 ± 24.57 cd	8.82 ± 0.23 cd	9.13 ± 0.17 e
Gb 03-027	843.75 ± 112.74 d	524.50 ± 86.19 cd	5.65 ± 0.39 d	8.10 ± 0.25 e
Gb 05-155	700.24 ± 84.87 d	395.47 ± 56.63 cd	5.49 ± 0.13 d	6.60 ± 0.22 e
Gb 19-082	929.72 ± 52.72 d	247.42 ± 25.21 cd	7.86 ± 0.07 d	8.08 ± 0.09 e
Gb18 -909	1033.47 ± 27.54 d	208.54 ± 25.79 cd	7.85 ± 0.40 d	8.68 ± 0.13 e
Gb 19-007M	920.45 ± 98.89 d	135.52 ± 45.17 d	6.78 ± 0.49 d	7.11 ± 0.29 e
Gb 18-106	630.98 ± 55.05 d	121.54 ± 69.62 cd	4.82 ± 0.29 d	5.97 ± 0.19 e
Desi				
GB Cappuccino	5527.08 ± 58.21 c	1563.17 ± 51.53 bc	60.98 ± 14.16 b	131.14 ± 3.27 cd
Gb 19-084 UPL 4	5692.00 ± 211.31 c	1078.71 ± 79.07 bcd	34.86 ± 3.10 bc	151.27 ± 7.18 bc
Gb 20-031 D	11839.59 ± 132.14 a	2364.01 ± 94.03 a	98.82 ± 18.61 a	272.95 ± 9.94 a
Gb 20-031	10127.88 ± 136.48 a	2632.28 ± 60.61 a	109.37 ± 19.13 a	188.07 ± 7.00 ab
Gb 20-072	10960.55 ± 189.51 a	2421.70 ± 64.53 a	113.05 ± 15.63 a	161.80 ± 2.61 bc
Gb 20-074	7896.43 ± 134.27 b	1994.28 ± 50.49 ab	87.86 ± 7.54 a	139.29 ± 7.87 bcd

Values are means ± SD, n = 3. Means accompanied by the different letters in the same column indicate significant difference between samples ($p < 0.05$). GAE: gallic acid equivalent. CE: catechin equivalents.

Table 4. Phenol Antioxidant Index (PAOXI)[a] and Flavonoid Antioxidant Index (FLAOXI)[b] for chickpea whole seeds and coats

Samples	Whole Seeds				Seed Coats			
	PAOXI ABTS	PAOXI DPPH	FLAOXI ABTS	FLAOXI DPPH	PAOXI ABTS	PAOXI DPPH	FLAOXI ABTS	FLAOXI DPPH
BRS Cristalino	8.69	1.41	24.92	4.04	6.31	8.52	12.26	16.55
BRS Toro	7.42	1.09	31.53	4.61	6.02	7.23	12.30	14.77
BRS Aleppo	8.83	0.60	24.21	1.65	8.81	11.81	11.92	15.98
BRS Cícero	6.61	0.36	21.25	1.17	10.49	11.97	28.55	32.56
GB Zeus	7.48	1.24	25.71	4.28	8.86	14.22	38.00	61.03
Gb 06-025	6.93	0.95	21.54	2.96	8.58	10.53	8.25	10.13
Gb 19-079	7.14	1.11	29.25	4.55	9.01	9.38	21.55	22.44
Gb 06-068	6.90	0.82	23.19	2.76	8.00	8.29	31.06	32.19
Gb 03-027	8.58	0.90	20.49	2.14	6.70	9.60	10.78	15.45
Gb 05-155	8.85	0.76	20.35	1.76	7.84	9.42	13.89	16.68
Gb 19-082	7.16	0.47	20.54	1.35	8.45	8.69	31.76	32.64
Gb18 -909	7.84	1.37	18.39	3.22	7.60	8.40	37.66	41.62
Gb 19-007M	7.87	1.27	28.36	4.56	7.37	7.72	50.06	52.44
Gb 18-106	7.52	0.29	24.47	0.95	7.64	9.46	39.68	49.10
GB Cappuccino	10.85	1.87	29.45	5.08	11.03	23.73	39.01	83.89
Gb 19-084 UPL 4	13.85	1.58	61.27	6.98	6.12	26.58	32.32	140.23
Gb 20-031 D	11.21	1.90	32.84	5.56	8.35	23.05	41.80	115.46
Gb 20-031	12.64	1.73	43.03	5.88	10.80	18.57	41.55	71.45
Gb 20-072	11.27	1.54	38.43	5.24	10.31	14.76	46.68	66.81
Gb 20-074	11.75	1.55	38.41	5.07	11.13	17.64	44.06	69.85

[a] PAOXI was calculated by dividing the ABTS or DPPH radical-scavenging activity of the sample (µmol of equivalent of TROLOX/g of seeds or coats) by the total phenol (µg/g of seeds or coats). [b] FLAOXI was calculated by dividing the ABTS or DPPH radical-scavenging activity of the sample (µmol of equivalent of TROLOX/g of seeds or coats) by the total flavonoids (µg/g of seeds or coats).

compounds identified in chickpea seed coats are presented in several studies as potential health promoters due to their strong absorption potential in the gastrointestinal tract (Matsumoto *et al*. 2001). They also exhibit cytotoxic effects against prostate carcinoma cell lines and hepatoprotective properties (Husain *et al* 2022).

These findings highlight the importance of retaining seed coats in various preparation methods for consumption, as many traditional practices involve removing them (Kaur and Prasad 2011). Additionally, chickpea seed coats are known to contain soluble and insoluble fibers, along with essential minerals, further enhancing their nutritional value (Zhong *et al*. 2018).

CONCLUSION

The data suggest that chickpeas cultivated in Brazil exhibit quality traits comparable to those of other cultivars reported in the literature. Despite the lack of clear differences between desi and kabuli types in composition and trypsin inhibition activity, desi seeds with brown seed coats stood out in terms of phenolic content and antioxidant activity. These results underscore the significant contribution of seed coats to the observed outcomes.

ACKNOWLEDGEMENTS

We acknowledge Sr. Osmar Artiaga from the AgroGarbanzo Produção Agrícola LTDA, Cristalina-GO/Brazil, for providing the chickpea samples. This work was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES (Finance Code 001 and PDPG), the Fundação de Amparo à Pesquisa do Estado de Minas Gerais – FAPEMIG Brasil (APQ-01240-21; JAD and RAVP Scholarship) and the Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq/ MCTI – (grant number 421595/2023-0; Scholarship: SAMD PIBIC-Af, ACBS PIBIC).

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