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Utilization of Date Pulp and Pit Powder to make Decaf Coffee to Improve Cognitive Health

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ABSTRACT

The health-conscious consumers are interested in replacing health-deteriorating drinks with functional beverages in current epochs. There is no higher truth that coffee consumption reduces risk of type II diabetes, Alzheimer, and other brain anomalies but it is also the fact that CGA (chlorogenic acid) and caffeine in coffee may pose risk of cardiovascular diseases and unhealthy mood fluctuations. Various health concerns of coffee consumption urge the need to produce a caffeine-free healthy alternative to coffee, which should also acquire the taste attributes of coffee. The development of instant coffee powder using date seeds and pomace powder for improved cognitive function can break new grounds in the market. The goal of the current study was to investigate the compositional profile of coffee prepared from date pomace and date seed powder. Date seeds were roasted at 200 °C for 20 min and a blend was made in combination with date pomace, milk powder and coconut as flavor enhancer. Proximate analysis of coffee powder such as moisture, ash, crude fat, crude protein, crude fiber and NFE percentages was determined. The results showed that prepared coffee powders contained significant fiber, low fat, less protein and a nearly equal percentage of moisture and ash as compared to *Coffea arabica* powder (control), with nearly zero caffeine content. Preliminary tests such as color, acidity, calories, total polyphenols, DPPH test, and FRAP assay were carried out because the study attempted to replace Arabica coffee beans with date beans. Phytochemical screening of coffee powders revealed that total phenolic content was highest for CB4 (20.90 ± 0.46 mg/g) which contained maximum date seed powder (35 %). Similarly, DPPH and FRAP assay were also found maximum for CB4 which were 81.11 ± 0.32 % and 23.17 ± 0.44 % respectively. Acidity and caffeine of prepared coffee powders were lower than control. It is hypothesized that decaf coffee may substitute caffeinated coffee for neurological health.

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INTRODUCTION

An increasing volume of research indicates coffee consumption to be linked with various health benefits. For example, studies have shown that coffee is associated with reduced risks for some common age-

related illnesses. In a meta-analysis encompassing various studies, it has been found that coffee consumption reduces 25 % risk for type II diabetes and 28 % risk for Alzheimer (Ho *et al.*, 2012; Kim *et al.*, 2012; Cropley *et al.*, 2012). Apart from this, coffee also triggers impaired glucose energy metabolism and cognitive brain dysfunction. The pros and cons of coffee can be endorsed in one with decaf coffee production. Studies unveil that where highly caffeinated coffee, with loaded sugars, increases heart rate and blood pressure, causes rhabdomyolysis (breakdown of damaged muscle) along with psychological aversions, moderate amounts of coffee minimize rebound fatigue, improve gut motility and neuron function (Heitman and Ingram, 2017; Doepker *et al.*, 2022). Decaffeinated coffee may be preferable than normal for pregnant women and those taking specific drugs. Plant-based nutritional beverages can be proven complementary in this aspect. Although date seeds contain 10 times more polyphenols than the fruit of the same tree, they are classified as waste despite having a delicious coffee-like aroma when roasted and being a good source of dietary fiber, phytosterols, and polyphenols (Babiker *et al.*, 2020). For global food security, efforts should be made to use both date seeds and pulp economically. In the Middle East, all food manufacturing businesses create 5,000 tons of date plant parts that are not edible. (Al-Farsi and Lee, 2011). Thus, the companies are in continuous efforts of boosting their revenue with minimum fiscal input via utilization of agro-waste. Nutrification and functional foods production has become an intervention to combat many chronic neurological ailments. These functional food items can be used instead of prescribed medications to treat serious illnesses like cancer, diabetes, oxidative stress, and anti-inflammation, among public. Both the edible and non-edible parts of dates include phytochemicals that may treat brain-related ailments. (Ataye *et al.*, 2011). Date palms (*Phoenix dactylifera*) are a member of the Areacaceae family (Palmae). Today, more than 150 different types of dates are produced, and according to statistics, Pakistan produces between 535,000 metric tons of dates annually. On the other hand, there is little research on dates' use in commerce or any other industry. Local farmers in Pakistan are currently cultivating the majority of indigenous types of date seeds including Zahidi, Zahri, Shamron, Dhaki, and Ajwa (Hossain *et al.*, 2014). Many indigenous economies are based on the date fruit. This fruit's Birhi and Safri types include 14% glucose, 13% fructose, and 53% sucrose, making them extraordinarily rich in sugars. Additionally, date pulp (mesocarp) includes 2% protein and 14% total dietary fiber, with insoluble fiber accounting for 10% of the dry matter overall (Dayang *et al.*, 2014). Dried dates have been found to contain vitamins B2, B3, B6, and B9, which account for 10% of the adult RDA (Recommended Dietary Allowance). Dates also contain an adequate quantity of vitamins A, C, and B1 (Mrabet *et al.*, 2019).

Date seed extracts are less bitter and have a less coffee-like flavor than regular *Robusta* or *Arabica* coffee (Ghnimi *et al.*, 2015). However, this does not necessarily make them unfit as a coffee substitute. Date seeds of the Saudi Ajwa variety were subjected to GC analysis, which showed that they contained saturated and monounsaturated fatty acids such as caprylic acid, myristic acid, octadecane, and lauric acid. (Qadir *et al.*, 2017) In the stomach and small intestine, caffeine is swiftly and completely absorbed and distributed to all tissues, including the brain. Caffeine ingestion has a number of neurological effects, including CNS stimulation, a significant increase in circulatory strain, and an accelerated metabolic rate. Additionally, caffeine promotes heartburn, which is the most typical issue experienced by coffee drinkers (Stevens *et al.*, 2021). Date seeds can be used in place of coffee to make a caffeine-free beverage that is nonetheless tasty and creamy (Venkatachalam and Sengottian, 2016b). The study's goal was to make a cup of instant coffee out of date seeds and discover its health impacts.

MATERIAL AND METHODS

The research was conducted at National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan. Date seed and date pulp were used to make coffee powder for this purpose. Afterward, the sensory and qualitative attributes of caffeine-free instant coffee were evaluated to boost cognitive health.

Procurement of raw material

Zahidi variety of dates *(Phoenix dactylifera)* was procured from local market for the preparation of coffee powder.

Preparation of date seed powder and date pomace powder

The date fruit was sorted, grated, and thoroughly washed before proceeding towards the preparation of powder. Flesh was separated from fruit. Date pits were

soaked overnight and dried. Date seeds were roasted at 200° C for 21 min. (Fikry *et al.*, 2019a). Optimum temperature handling reduced moisture content and decreased hardness with minimum loss of phenolic and antioxidant content in roasted date seeds (Fikry *et al.*, 2019b). After roasting, they were ground to very fine powder using grinder muller. The pulp was dried in a dehydrator and ground to very fine pomace powder using pestle and mortar. Both date pulp and date seed powder were proceeded for product development.

Formulation of coffee powder

For the formulation of a decaf instant coffee powder (20g) , date seed and date pulp powder were added in different proportions as mentioned in the table 1.1, keeping the proportion of whole milk powder (6g), grated coconut (1g) and brown sugar (1g) constant to target the most suitable composition for our product. The coconut was used as a favor enhancer because it has good aromatic properties and taste attributes (Bell *et al.*, 2008).

Table 1. Treatment Plan.

	Date seed powder (DSP) %	Date pulp powder (DPP) %	Whole milk powder (WMP) %	Grated coconut powder (GCP) %	Brown sugar (BS) %
CB0	Nescafe gold premix coffee powder				
CB1	20	40	30	5	5
CB2	25	35	30	5	5
CB3	30	30	30	5	5
CB4	35	25	30	5	5

Compositional analysis of instant coffee powder

Proximate analysis: The basic composition of instant coffee powder was determined on dry-weight basis (AOAC, 2019). The moisture, ash, crude fat, crude protein, and crude fiber were calculated using standard AOAC, 2019 methods. Nitrogen free extracts were determined by subtracting above calculations from 100.

$$NFE\ \% = 100 - (moisture + ash + crude\ fiber + crude\ protein + crude\ fat)$$

Production of coffee: For one cup of coffee, one sachet was used. The sachet was poured into the cup. A total of 150 ml of hot water was added. The mixture was continuously mixed until it was brewed in hot water or foaming was produced. The coffee was subjected to further testing (Venkatachalam and Sengottian, 2016a).

Analyzing the contents of chlorogenic acid and caffeine using HPLC

To produce decaf coffee, the contents of caffeine and chlorogenic acid were calculated using high-pressure liquid chromatography (HPLC).

Preparation of coffee extracts: Coffee extracts were filtered with a 25 mm Polyvinyl Difluoride (PVDF) syringe filter. These filters have a 0.45 micrometer pore size (Agilent Technology).

Material required: Methanol + 2 % acetic acid (70:30) solution, caffeine aqueous solution at 40 μg/mL, theophylline + paraxanthine (standards), and HPLC.

Determination of chlorogenic acid and caffeine: Sample were loaded into the column and were separated based on their affinity for the stationary phase. Caffeine and chlorogenic acid compounds were separated based on their partitioning coefficients. For this, first blank sample and then corresponding samples were run and standard/calibration curves were recorded on UV-visible detector (Tsai and Jioe, 2021).

Determination of functional potential of coffee

Extraction and fractionation of beverages: Extraction of caffeinated and decaf beverages were made using aqueous methanol according to protocol of Boudghane *et al.* (2022). For the purpose, coffee was added in 149 ml of aqueous methanol in 250 ml conical flask, following the addition of 1 ml of acetic acid and 40 ml of distilled water. Mixture was kept in an orbital shaker at 280 rpm at 20° C for 3 hours. Latterly, Whatman filter paper No. 2 was used for filtration. The extract was separated from solvent at 40° C. The final extract was proceeded for analyses.

Total phenolic count: Date seed extracts were subjected to Folin-Ciocalteau method for total phenolic count. It is based upon method that uses UV-1601 spectrophotometer and Folin-Ciocalteau reagents (Neo *et al.*, 2008; Biglari *et al.*, 2009). The total phenolic count was calculated in milligrams of gallic acid / 100.

Total flavonoids: The total flavonoid content was

checked by preparing the standard solution and checking the absorbance against blank at 510 nm. The total flavonoid content was expressed in mg Catechin Equivalent per 100g (CE/100g) (Platat *et al.*, 2014).

2,2-diphenyl-2-picrylhydrazyl radical scavenging (DPPH) assay: Free radical scavenging activity or 2,2-diphenyl-2-picrylhydrazyl (DPPH) assay of date mix coffee was calculated under standard procedure as elaborated by Juhaimi *et al.* (2012) and Brezova *et al.* (2009). 4 ml of ascorbic acid and 1 ml of DPPH were mixed to make positive control. For negative control, 1 ml of DPPH was mixed with distilled water. 4 ml of extract was added to 1ml DPPH. The mixture was incubated at room temperature for 20 min and the absorbance was determined at 520 nm using spectrophotometer.

Physicochemical analysis of caffeinated and decaf coffee

Titratable Acidity: The total acidity using titration method of AOAC (2019) of the samples was determined. Accordingly, a known volume of sample (10 ml) was added to a beaker. Two drops of phenolphthalein were added. The beaker was placed under burette opening, already filled with 0.1 N NaOH. NaOH was dripped dropwise in the sample till the color of solution turned to purplish pink. The difference in the reading of burette was noted and titratable acidity was calculated using formula.

Color: The color value was quantified using L*a*b*color space system. L* value showed its brightness. Degree of greenness (-a) or redness (+a) and blueness (-b) or yellowness (+b) was checked according to protocol (Manickavasagan *et al.*, 2015). Chroma (C*) and hue angle were calculated using the data obtained.

Total Calories Count: By employing a ballistic bomb calorimeter, the traditional method was used to determine the calories in each product (Manickavasagan *et al.*, 2015). 5 samples (about 1 g) were prepared into pallets and put into crucibles to measure calories. The crucibles were positioned inside the pedestal-mounted bomb calorimeter. Inside the device, a cotton thread, with the other end inserted into the crucibles, was linked to a platinum filament to ensure even burning throughout. The thermocouple was positioned on top of the calorimeter and the chamber was sealed. The current was conducted through the filament for 35 seconds while the chamber was filled with oxygen at a pressure of 400 lb/in3. The thermocouple recorded the temperature change on chart paper after measuring it.

Sensory Analysis: Trained panelists evaluated the product using a nine-point hedonic scale. The product's several attributes, including taste, flavor, color, sweetness, and overall acceptability, were evaluated. (Jambi, 2018).

Statistical analysis

The data was analyzed for computing the level of significance as determined by Montgomery (2017).

RESULTS AND DISCUSSIONS

Comparing composition of proximate material from caffeinated and decaffeinated coffee powders

The compositional analysis of coffee powders revealed that a decaffeinated beverage can be a robust substitute of coffee for neurological patients. The mean values of moisture content of coffee powder presented in table 1 showed that moisture content of all coffee powders prepared in laboratory were lower than the control except CB2 which contained 30 % date seed powder + 30 % date pulp powder. As the concentration of date pulp powder changed, the moisture content of coffee powders was also noted to be changed. The existing results were in synchronization with the findings of Mussatto *et al.* (2011), who revealed that maximum moisture in coffee powder should not be greater than 10%. The mean values for ash content (Table 1) were comparable to research findings of Ozdestan (2014), who reported the total ash contents (%, w/w) of brewed coffee samples in between 0.12% and 0.28%. The current findings reveal that total ash content in prepared samples was in ample amount. The ascending mean values for fat content from CBo to CB4 was due to high percentage of date seed powder as compared to date pulp powder ascendingly (Table 1). In a similar study, when apricot-date bars were prepared using date and apricot paste, the results indicated no significant change on varying date paste quantity in composition (Nadeem *et al.*, 2012). Thus, only the fat contributor in coffee powder were date seeds and coconut. Higher was the percentage of date seed in the compositional base, higher amount of dietary fiber in coffee powder was reported (Table 1).

Table 1. Proximate analysis of caffeinated and decaffeinated coffee powders.

Treatments	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)	NFE (%)
CBo	3.35±0.025^{b}	1.78±0.04^{c}	11.87±0.59^{b}	8.26±0.23^{a}	60.45±0.56^{c}	14.23±0.76^{a}
CB1	3.16±0.021^{c}	1.93±0.05^{b}	10.16±1.02^{c}	7.62±0.18^{b}	55.50±0.15^{e}	14.24±0.23^{a}
CB2	3.41±0.017^{a}	1.92±0.02^{b}	11.25±0.47^{bc}	7.25±0.22^{b}	61.99±0.12^{b}	14.07±0.56^{b}
CB3	3.06±0.021^{d}	1.99±0.04^{b}	15.53±1.34^{a}	6.26±0.10^{c}	58.57±0.90^{d}	13.30±0.72^{c}
CB4	3.15±0.031^{c}	2.25±0.05^{a}	15.66±0.86^{a}	5.48±0.47^{d}	65.66±0.75^{a}	13.77±0.07^{c}
LSD	3.23± 0.139	1.97± 0.17	12.90 ± 2.47	6.975± 1.050	60.43 ± 3.55	14.34 ± 0.92

All results are expressed as means ± standard deviation; Values in each column which have different letters are significantly different ($p < 0.05$).

Production of coffee

Five sachets were prepared for each of the five treatments, yielding five samples of coffee. The first treatment was labelled as the control, while the following treatments contained a variety of date seed and pulp combinations. The produced compounds were evaluated physiochemically and tested for antioxidant potential.

Comparison of chlorogenic acid (CGA) and caffeine content in caffeinated and decaffeinated coffee powders

The concentration of caffeine and CGA in brewed beverages was found significant. The concentration of caffeine and CGA in green (date seed) coffee were 1.23 ± 0.92 mg/L and 2.24 ± 0.56 mg/L in CB4 respectively, which contained maximum date seed powder. Erstwhile, 85.53 ± 1.97 mg/L CGA and 100.85 ± 2.81 mg/L caffeine were found in standard coffee samples. The results demonstrated that standard coffee contained maximum CGA and caffeine as compared to green coffee, which agrees with the result of McCusker *et al.* (2006), who found 75.8 mg/shot in highly caffeinated and 3.2 mg/shot in decaf coffee. This proves that a decaf coffee with taste attributes of coffee could be produced using dates.

Table 2. Chlorogenic acid (CGA) and caffeine content in caffeinated and decaffeinated coffee powders.

Treatments	Chlorogenic acid (CGA) [mg/L]	Caffeine [mg/L]
CBo	85.53±1.97^{a}	100.85±2.81^{a}
CB1	1.16±0.021^{b}	0.93±0.05^{d}
CB2	1.41±0.017^{b}	0.02±0.78^{d}
CB3	0.06±0.01^{c}	1.99±0.45^{c}
CB4	1.23±0.92^{b}	2.24±0.56^{b}
LSD	2.37±0.52	2.70±0.43

Different letters indicate that the values are significantly different. ($p < 0.05$).

Phytochemical screening and antioxidant potential of decaf coffee

Comparison of total phenolic content (TPC) in caffeinated and decaffeinated coffee: Wholesome health-associated advantages of polyphenols have required their evaluation in different food items. The values of TPC acquired from different treatments through solvent extraction are presented in mg GAE/g of dry weight. Significant differences in the TPC were observed between treatments applied (Figure.1). Krol *et al.* (2020) have analyzed the chemical composition of freshly simmered and stored coffee from natural and synthetic products. Freshly roasted organic coffee had 8.95 0.77 mg/g total polyphenols, whereas stored organic coffee contained 1.41 0.17 mg/g. Likewise, 8.28 1.16 mg/g polyphenol was detected in the control and 20.9 mg/g in CB4, which contained the greatest percentage of date seed powder.

Comparison of DPPH assay in caffeinated and decaffeinated coffee: The quality and storage duration of fat and fiber-rich products is legitimately connected with ideal stabilization by an appropriate antioxidant agent. The mean values regarding DPPH assay of date coffee are presented in Figure 2. The DPH radical scavenging activity of the extract was observed maximum with CB4 (81.11 ± 0.326) while CB1 showed

minimum (77.40 ± 1.011) antioxidant potential in comparison to control group CBo. The results are in harmony with the findings of Maqsood *et al.* (2015). They observed that various specific varieties of date seeds can be proved as an alternative source of natural chelating agent and antioxidant compounds.

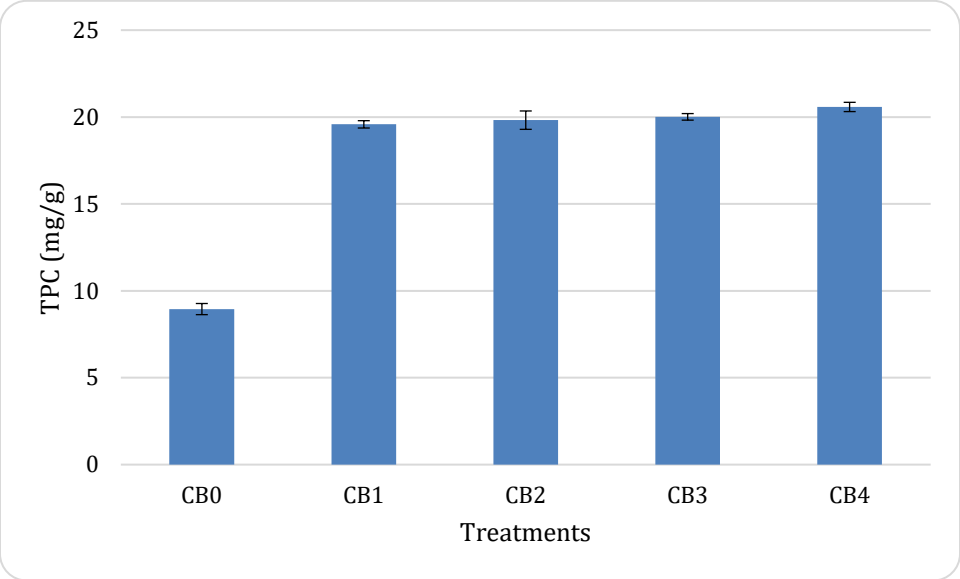

Figure 1. Total phenolic count in caffeinated and decaf coffee. Bars represent standard errors of the mean values.

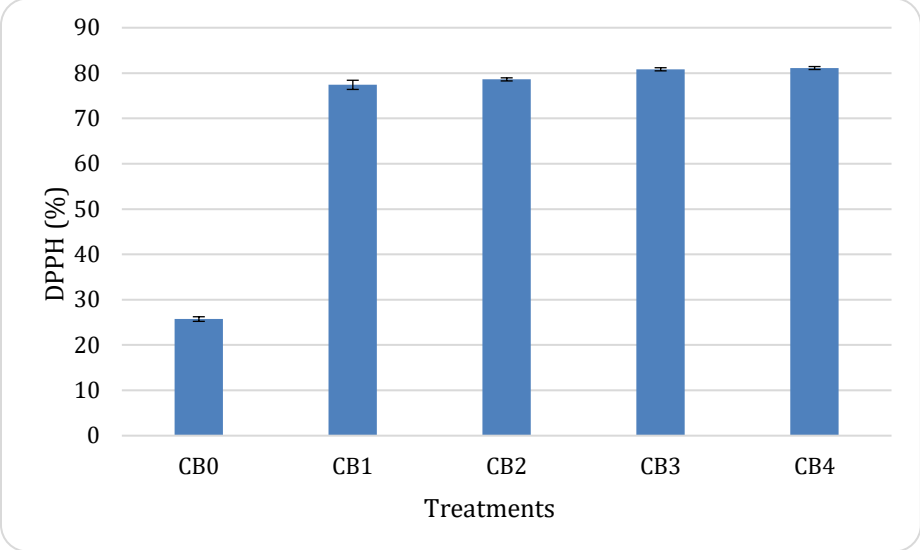

Figure 2. DPPH percentage in caffeinated and decaf coffee. Bars represent standard errors of the mean values.

Comparison of FRAP assay in caffeinated and decaffeinated coffee powders: Figure 3 illustrates the mean values indicating the antioxidant capacity of date coffee in terms of FRAP. Mean value of FRAP assay of coffee was maximum for CB4 23.17 ± 0.445, followed by CB0 19.627 ± 0.290; CB3 15.01 ± 0.742; CB2 12.61 ± 0.624, while CB1 attained minimum value 10.93 ± 0.292 in terms of FRAP. All values are expressed as mean ± standard deviation. The present findings are in connection with the work of Alem *et al.* (2017) that depicted antioxidant activity in terms of FRAP for Boufgous seeds as 14.299 ± 0.275 mmol TE/100 g, for Bousthammi seeds as 22.863 ± 0.358 mmol TE/100 g and 10.966 ± 0.339 mmol TE/100 g for Majhoul seeds. In a similar study, FRAP was utilized to quantify the antioxidant potential of water-soluble compounds of

coffee and was described as ascorbic acid equivalent antioxidant potential in mg/g of the dried coffee compounds. The mean values of FRAP assay for Wembera, Burie, Goncha and Zegie coffees were 9.532 ± 0.201, 9.159 ± 0.441, 8.955 ± 0.180 and 6.751 ± 0.284 respectively (Tewabe, 2015). It can be concluded by comparison of current investigations with above research findings that replacement of Arabica coffee beans with date seeds and pulp can increase antioxidant potential of coffee in terms of FRAP assay.

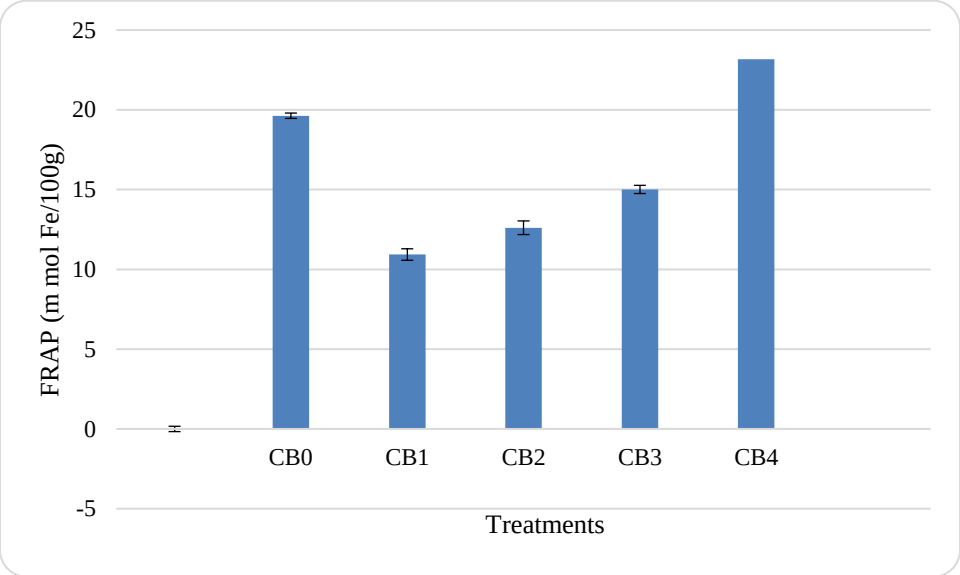

Figure 3. Comparison of FRAP assay in caffeinated and decaf coffee. Bars represent standard errors of the mean values.

Comparison of flavonoid content in caffeinated and decaffeinated coffee: Mean squares for total flavonoid content showed significant difference due to treatments. The existent findings are in consonance with the work of Bouhlali *et al.* (2017). They evaluated three Moroccan date palm varieties for nutrient, phytochemical, and proximate compositions. The flavonoid content was found in a range of 1224–1844 mg Rutin equivalent/100 g. Previous studies and current research indicate that utilizing date seeds and flesh may result in a more enhanced and healthier functional by-product.

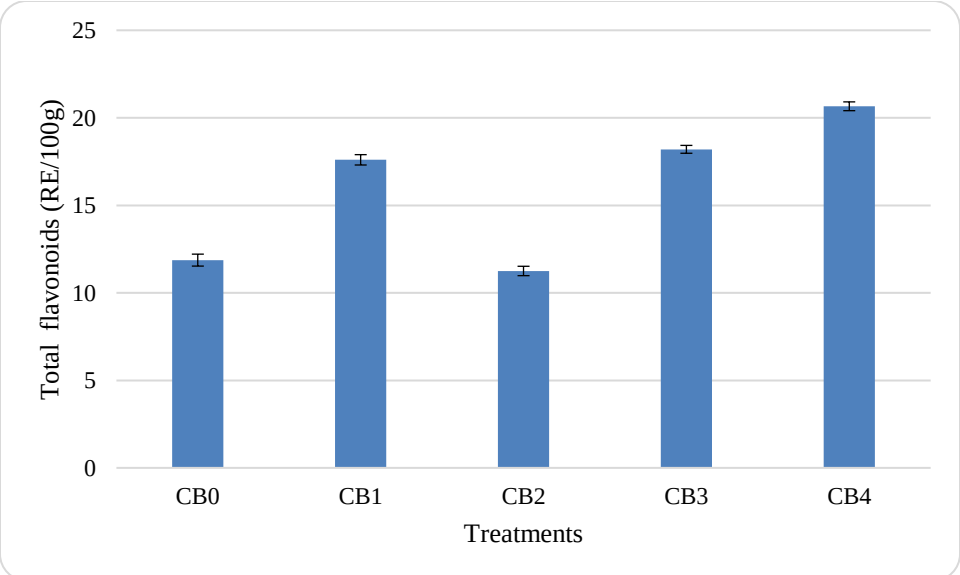

Figure 4. Total flavonoid content in caffeinated and decaf coffee. Bars represent standard errors of the mean values.

Total titratable acidity of instant coffees: The acidity percentage of coffees seemed to be influenced by kind of organic acids and minerals concentration present in fruit. When Anthon and Barrett (2012) studied the influence of pectin methyl esterase and other factors on processing of tomatoes, they observed that pH and titratable acidity of cold break and hot break juices was highly influenced by minerals and organic acid concentrations. Previously, sensorial properties of *Pistacia terebinthus* fruit coffee were determined by Secilmis *et al.* (2015). Our current results are in harmony with researcher findings as their titratable acidity of fruit coffee after microwave roasting was 165.48±0.53 ml NaOH/100 g coffee and titratable acidity for Turkish coffee was 420.19±0.48 NaOH/100 g coffee. This difference indicates greater acidity percentage in original coffee, while fruit coffee is less acidic and can be used by people with stomach disorders.

Table 3. Total titratable acidity of instant coffees.

Treatments	Means
CBo	2.01±0.11[a]
CB1	1.06±0.20[c]
CB2	0.81±0.32[d]
CB3	0.76±0.78[e]
CB4	1.34±0.012[b]
LSD	1.20 ± 0.50

All results are expressed as means ± standard deviation. Different letters indicate that the values are significantly different. ($p < 0.05$).

Color of coffees: Mean value for L value of coffee was non-significantly different among CB0, CB1 and CB2 which were significantly different from later treatments; CB3 and CB4. The color differences among the coffee samples are probably because these values are calculated outside the human vision. Since date pulp powder contains more sugar crystals than seeds, and crystals increase the transparency of prepared product. The color values of coffees might be fluctuating due to opacity of seed powder as compared to pulp, which contained more crystals (Kathiravan *et al.*, 2015).

Table 4. Mean squares for color tonality of instant coffees.

SOV	Degree of freedom	L* value	a* value	b* value	Chroma	Hue angle
Treatments	4	201.21*	103.01[NS]	106.14[NS]	11.89**	0.054*
Errors	10	24.31	258.64	154.37	0.94	0.005

** = Highly significant; * = Significant; NS = non-significant.

Total calories count

The mean values for total calories of coffees are presented in Figure 5. The results show that caloric value was maximum for CB1 and CB2 which contained 40 % and 35 % date pulp powder respectively. The rest of the treatments, which were present with less pomace powder also showed less caloric value. The less caloric value of CBo, which was control group, was probably due to fact that it contained caffeine. Caffeine was decreasing caloric value of prepared beverage. (Buzby *et al.*, 2014). Sugar seemed to be a contributing factor for high caloric value of coffee beverage. When Singh *et al.* (2012) conducted a study on comparative analysis of nutritional profile of date palm varieties from Sultanate of Oman, they also observed a similar approach. One average size of Deglet Noor date variety contained 20 calories/ g, along with 5.33 g of total carbohydrates.

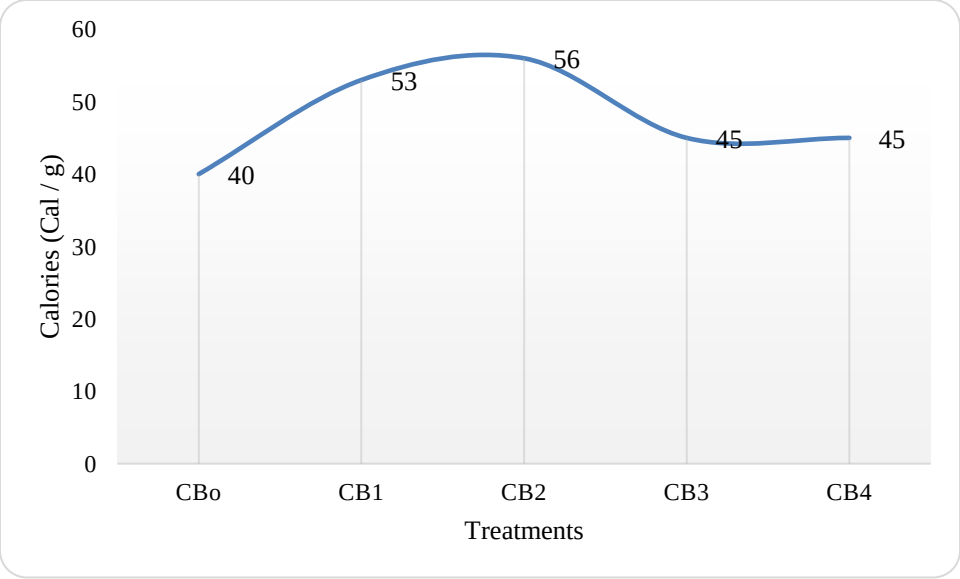

Figure 5. Calorie comparison of caffeinated and decaffeinated coffee.

Sensory evaluation of instant coffees

The mean values for sensory evaluation of instant coffees revealed the momentous variation on color, flavor, overall acceptability, and taste as a function of treatments. The effect of date seeds and pulp composition on color, flavor and overall acceptability of prepared coffees was significant and highly significant for aroma, while non-significant for appearance of instant coffees (Table.5). Color is an important parameter when it comes to sensory attributes, but color seems to be affected by packaging of coffee powders and exposure of some prepared packages to more sunlight (Mielby *et al.*, 2018).The reason for strong aroma of CB0 (control) was due to presence of pure *Arabica* Coffee beans and thus presence of caffeic acid in powder which has pungent smell (Marek *et al.*, 2020). The reason behind the same appearance of prepared products might be the color similarities of Arabica Coffee beans with date seed powder, which has same brownish appearance (Niazi *et al.*, 2017). The flavour and colour of coffee might have changed due to variations in brewing methods. Colour of coffee might have gone more brownish due to increased brewing temperature and time. The sensory attributes like appearance were mildly affected by date seed and powder variations. Thus, sensory perception of novel coffee ingredients is the primary step to assess consumer response.

Table 5. Mean squares for sensory evaluation of instant coffees.

SOV	Degree of freedom	Color	Aroma	Flavor	Appearance	Overall acceptability
Treatments	4	1.43*	0.433**	2.43*	0.33^{NS}	0.10*
Errors	10	0.87	0.400	1.80	0.60	0.93

** = Highly significant; * = Significant; NS = non-significant.

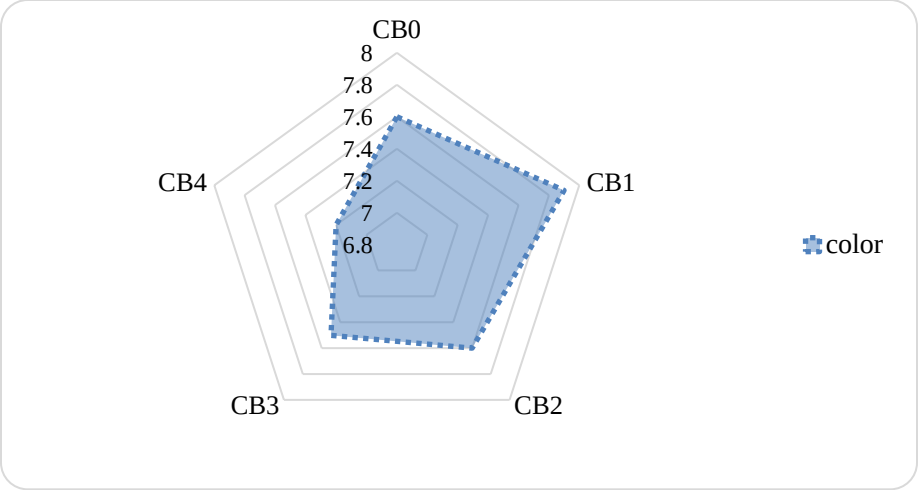

Figure 6(a). Color of instant coffees prepared from caffeinated and decaf coffee powders.

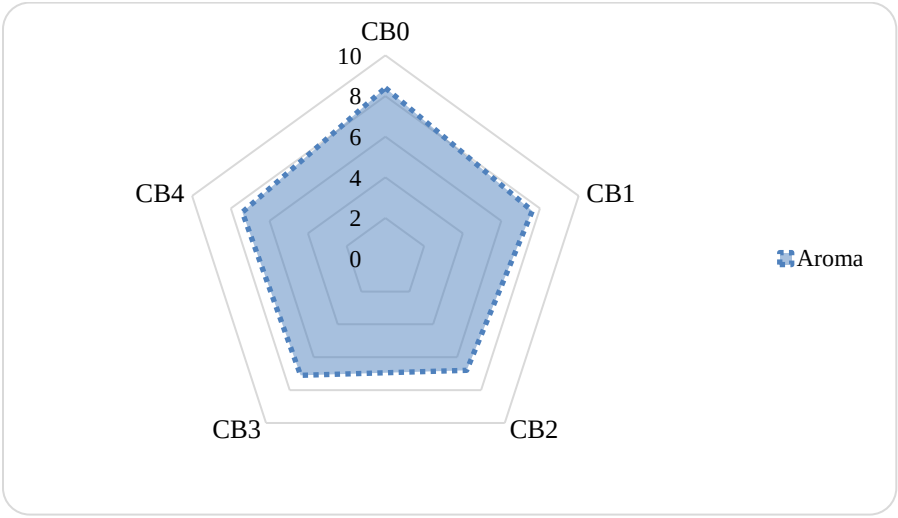

Figure 6(b). Aroma of instant coffees prepared from caffeinated and decaf coffee powders.

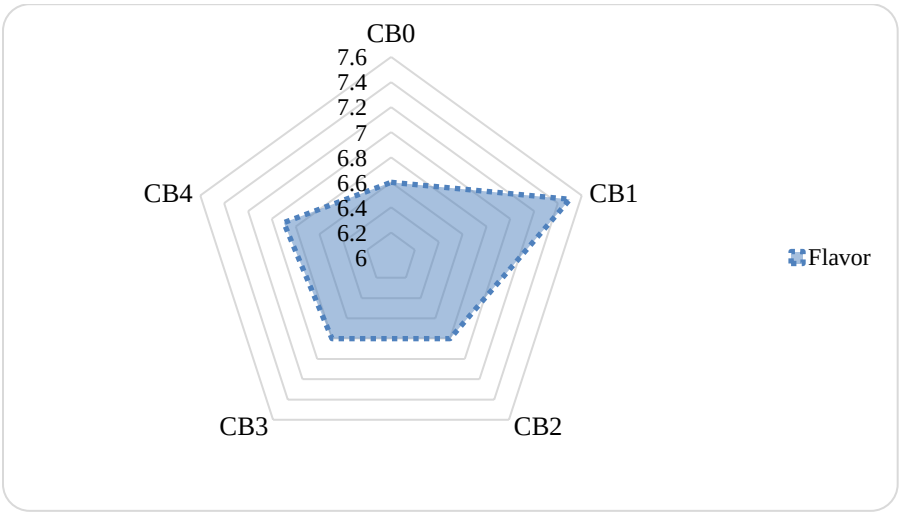

Figure 6(c). Flavor of instant coffees prepared from caffeinated and decaf coffee powders.

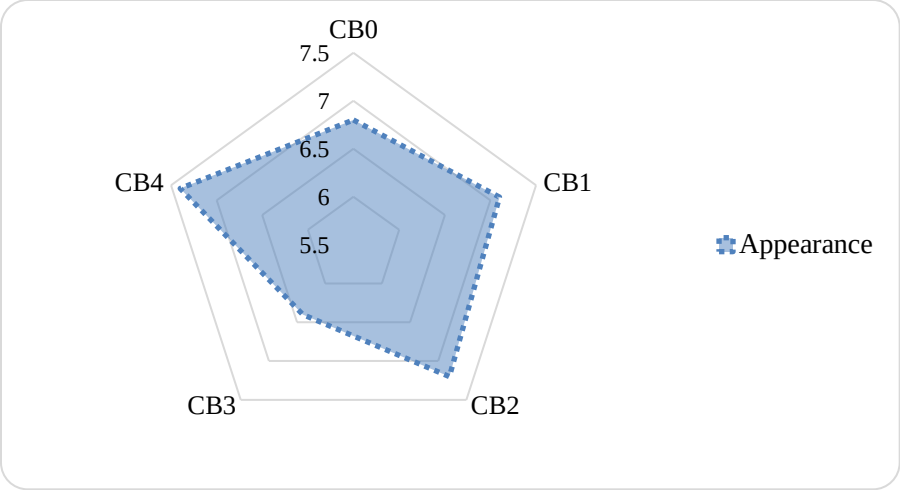

Figure 6(d). Appearance of instant coffees prepared from caffeinated and decaf coffee powders.

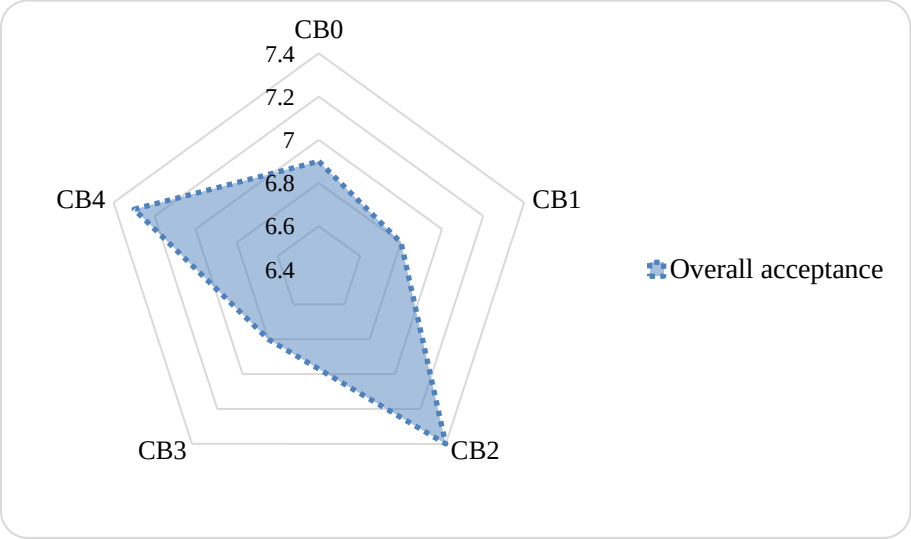

Figure 6(e). Overall acceptance of instant coffees prepared from caffeinated and decaf coffee powders.

CONCLUSION

With the creation of the date seed beverage, the innovation also put the idea of "waste to riches" to use. This can serve as a best alternative to traditional coffee for neurological patients. This decaf beverage contains almost no caffeine, which is the primary health detriment for those with cognitive health issues. It has the same flavor, calories, and phenolic content as regular coffee but without the caffeine that is detrimental to maternal and cognitive health. More intriguingly, the date seed coffee powder cost less to produce, at RM1.00/10g, because all the ingredients were natural, and water was used for extraction, as opposed to other health beverages, which were additional expensive because they required more steps in the production process. According to studies, date seed has ten times more minerals, vitamins, and antioxidants than a date, which could also stabilize blood sugar levels, improve insulin sensitivity, and act as an anti-cancer agent.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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