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Enhanced Solubility and Flavour Profile of Instant Date Seeds (*Phoenix dactylifera L.*) Coffee as Caffeine-Free Beverage

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The demand for decaffeinated coffee has increased due to the stimulatory effects of caffeine. Thus, the present work aimed to develop an instant date seed *(Phoenix dactylifera L.)* coffee (DSC) as a caffeine-free beverage. Physico-chemical and antioxidant properties of regular and instant DSC were compared. The moisture, water activity, pH, and solubility of instant DSC powder were significantly higher ($p<0.05$) than that of regular DSC powder. The total number of volatile compounds identified in instant DSC and regular DSC headspace was 40 and 28, respectively. The freeze-drying process to produce instant coffee resulted in a lighter colour of DSC but reduced its antioxidant activities. Nevertheless, the nutritional composition of instant DSC mainly remained the same due to the drying process. The sensory evaluation of brewed coffee results showed that the aroma and sweetness of regular DSC were moderate ($p<0.05$) than that of commercial coffee bean drinks. The colour, astringency, bitterness, sediments, and overall acceptability of regular DSC were compatible with commercial coffee bean drinks. The retention of flavour compounds and enhanced solubility as a results hot extraction and freeze-drying of soluble solids from date seed coffee are expected to improve the sensorial quality of the coffee for commercialization.

Keywords: Date seeds; caffeine-free; antioxidant; flavour profiles; instant coffee

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Coffee is one of the most consumed beverages in the world. However, coffee plants were vulnerable to climate change, which affects the sustainable production of coffee beans [1]. Furthermore, the stimulatory effect of coffee would lead to caffeine addiction in which it turns to other health issues for certain group of population. The production of decaffeinated coffee is not uncommon, but the extraction of caffeine was carried out by using organic solvent.

Volarization of food by-products is one of the strategies that is associated with the sustainable development goal [2]. It has become more important than ever in the face of ever-growing population. For example, the non-use or underutilization of date palm by-products for human consumption leads to a real economic loss since it is rich in phenolic compounds and dietary fibres for therapeutic purposes [3]. Date seeds generated from direct consumption and date processing have been well researched for their potential consumption in the effort to reduce food waste.

Date seed coffee (DSC) was well proven to be caffeine-free based on mass spectrometry analysis [4], gravimetric analysis [5] and Fourier transform infrared spectroscopy (FTIR) analysis [6]. The health benefits of date seeds are numerous such as anti-inflammatory properties [7], anti-nutritional substances [8] and antigenotoxic effects [9].

There have been few studies on functional and flavour properties of DSC as a substitute for coffee. Jamil et al. [10] reported that the optimal roasting temperature and time of defatted date seeds was 199.99 ℃ and 21.5 min, respectively to achieve high antioxidant activity, total phenolic content (TPC) and good sensory attributes in brewed DSC. Babiker et al. [11] reported that oil yield, ash and antioxidant activities were increased with roasting temperature from 180 to 220 ℃ for 20 min.

The effect of roasting temperature on volatile compounds of DSC, which is an important parameter of coffee beverage, is extremely limited. The volatile profile of the coffee extracts from roasted date seeds of *Bouhattam* variety showed the presence of 13 volatile

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compounds because of organic solvent extraction using cyclohexane, dichloromethane, and methanol. These compounds were mainly categorized into acids, sterols, alkanes, phenols, and aldehydes [4]. To the best of our knowledge, this is the only study that reported on the volatile profile of the DSC due to roasting.

The interest in utilisation of date seed as caffeine-free beverage has increased in recent years. Instant coffee is obtained from freshly ground-roast beans by extraction of liquid coffee extract with hot water [12]. This extract is either spray-dried or freeze dried to convert it into a soluble coffee powder. The production of DSC as an instant beverage should be considered and more data are required so that the industrial commercialization of caffeine-free beverage from date seed is possible. The objective of this study was to determine the physico-chemical properties, volatile profile, and sensory quality of instant DSC due to freeze-drying process.

EXPERIMENTAL

Chemicals and Materials

Potassium sulphate, selenium, concentrated sulfuric acid, boric acid, methyl red indicator, petroleum ether, sodium hydroxide, methanol, 2,2-Diphenyl-1-picrylhydrazyl (DPPH), Folin Ciocalteu reagent, Gallic acid, dichloromethane (GC grade) is obtained from laboratory located at UiTM Shah Alam in Applied Science Faculty. A 4000 g of date from Ajwa variety was purchased from a local store in Malaysia. The dates were stored in an airtight container at low moisture conditions and under refrigerated temperature to prevent any microbial contamination.

Preparation of Regular Date Seed Coffee (DSC) Powder

Date seeds were manually removed from the flesh. After numerous washings with water, the seeds were dried at room temperature (23–25 °C) for a day to remove any excess water from their surface. The date seeds were then cooked with medium heat (149–204 °C) until all seeds are evenly roasted for approximately 20 minutes with constant stirring. Roasting reduces the moisture content of the beans to 3%, accelerates the oxidation of phenolic compounds, and eliminates acetic acid, volatile esters, and other odour components [13]. After approximately 20 minutes of roasting, the freshly roasted seeds were cooled to avoid changes in quality and aroma. Roasted date seeds were milled by hammer mill (SFSP 66×100E Hammer Mill) and passed through 1.5 *mm* sized sieve to produce regular DSC powder.

Preparation of Instant Date Seed Coffee (DSC) Powder

The regular DSC powder was brewed in hot water (90 °C) with ratio of 1:16, which was one gram of powder in 16 ml hot water. The brewed extract of roasted date seed was frozen at -40 °C in freezer. It was then transferred into Martin Christ Gefriertrocknungsanlagen ALPHA 1-4 LD plus freeze dryer. The extract was formed into a thin film, which was subsequently shattered into granules. These deep-frozen granules contain water that must be extracted. To sublimate the granules, they were forced down a low-pressure tube for several hours and heated to 60 °C in a strong vacuum before instant DSC was obtained.

Physico-chemical Properties of Regular and Instant Date Seed Coffee (DSC) Powder

Moisture content was determined by using A&D MX-50 Moisture Analyzer. 1 g of DSC powder was placed and evenly distributed in the sample pan. Prior to drying, the cover was closed, and the START/ STOP button was pressed to start analysis. The result display for % moisture was read and recorded at the end of process.

Water activity was determined by METER Aqualab 4TE, Germany benchtop water activity meter. The instrument was warmed up for 15 minutes. The sample cup was filled no more than half full. The sample was inserted into the benchtop water activity meter, the reading of water activity was shown and recorded.

Colour was analysed by using a Konica Minolta Chroma Meter CR-400, Japan to determine its colour qualities. The protective cap from the light projection tube was removed to switch on the chromameter. The colour of sample was measured by filling the powder in a petri dish no more than half full and put the light projection tube on the surface of the sample. The result was displayed on the screen of device and was recorded.

Solubility of DSC powders followed the procedure by Ishwarya & Anandharamakrishnan [14]. A 1 g of ground powder was weighed, followed by the addition of 60 mL of freshly boiled water to a beaker containing the powder. The steps were repeated with instant powder, and solubility and the presence of lumps on the solution's surface, if any, was evaluated at the same time. The time required for complete dissolution with no surface lumps was recorded. The analysis was conducted in duplicate, and the average solubility time was determined.

The nutritional composition such as protein content, ash content, crude fat and total carbohydrates were determined in DSC powder following AOAC [15]. Crude fat was determined using the Soxhlet extraction method by the solvent extraction system (M Tops, FAM 9209-06, UK), whereas the crude protein was determined using the Kjeldahl method. Utilizing digestion (TUEBOSOG, Gerhardt, Malaysia) and distillation, the procedure was carried out (Vapoddst

45s, Gerhard4, Malaysia). The moisture content of the roasted date seed powder was measured by using A&D MX-50 Moisture Analyzer, and the ash content was measured using the dry-ashing method using a muffle furnace (Cober, Daihan Scientatie, South Korea). Total carbohydrate content was calculated as follows:

$$Total\ carbohydrate\ (\%) = 100 - (moisture + ash + crude\ protein + crude\ fat)$$

Antioxidant Activity of Coffee Extracts from Regular and Instant DSC Powder

The extracts were prepared according to the procedure described by Odzakovic et al. [16]. The regular and instant DSC powder was extracted with hot deionised (90 °C) water at a coffee/solvent ratio of 0.5/100 with continuous stirring for 5 minutes. The extracts were centrifuged at 2000 rpm for 5 minutes. Each sample was extracted for three cycles. The pH of extract was measured by Benchtop PEAK INTRUMENTS pH Meter. The extracts were kept at a temperature of -20 °C until analysis.

The 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay was conducted in accordance with the method described by Liyana-Pathirana and Shaidi [17]. 1 ml of a 0.135 mM DPPH methanolic solution was added to 1 ml of the DSC extract. 0.135mM DPPH methanolic solution was prepared with 39.4 mg DPPH powder in 1000 mL methanol. After 30 minutes in the dark, absorbance was measured at 515 nm alongside a blank. The equation was used to calculate the DPPH radical scavenging activity:

$$\text{DPPH scavenging activity (\%)} = \frac{Absorbance_{Control} - Absorbance_{sample}}{Absorbance_{Control}} \times 100$$

The total phenol content (TPC) of DSC extract was determined spectrophotometrically (UV/Vis Thermo Scientific Genesys 20 spectrophotometer). A 0.2 mL of Folin-Ciocalteu reagent 0.6 mL of 7.5% Na_2CO_3 was added to 40 µL of diluted extract. Absorbance was measured at 765 nm after 1 hour storage in a dark place and at room temperature along with the blank. Gallic acid was used as standards and the results were expressed as mg gallic acid equivalents (GAE)/g of coffee sample.

Identification of Volatile Compound in Regular and Instant Date Seed Coffee (DSC) Powder

The identification of volatile compounds from regular and instant DSC powder was carried out using headspace solid-phase microextraction coupled to gas chromatography mass spectrophotometry (HS-SPME/GC-MS) (Agilent Technologies 7890A-Agilent GC-MS). A 0.2 g of each sample was mixed with 2 ml dichloromethane (GC grade) and was filtered by using a syringe filter. The volatile compounds were identified by comparison of their mass spectra with those obtained in NIST 14 Software.

Sensory Evaluation of Brewed Coffee Beans and Date Seed Coffee (DSC) Beans

The brewed coffee was evaluated by 50 untrained panellists from UiTM, Shah Alam campus, Malaysia. The sensory evaluation was carried out using a 9-point hedonic scale test. The panellists were given two samples, a commercial coffee bean powder drink and regular DSC drink coded with a random three-digit number. The drinks were prepared by mixing 75 g of ground coffee with 60 °C hot water. 20 g of sugar was added along with 15 g of creamer to prepare 1000 ml of brewed coffee. Both drinks were served cold at temperatures of 1.7 to 3.3 °C. The panellists need to rinse their mouth with water before tasting and between each sample tasting. The panellists need to taste the samples from the left to right. Sensory evaluation was conducted by using the hedonic scale of 9 to 1 scale where 1 is 'dislike extremely', 5 is 'neither like nor dislike' and 9 is 'like extremely'.

Data Analyses

All measurements were performed three times (n=3). The total and mean scores per attribute were calculated. The value was analysed statistically for product difference each attributes using paired samples t-test. The significant difference was set at 5% level.

RESULTS AND DISCUSSION

Physico-chemical Properties of Date Seed Coffee (DSC) Powder

The moisture content, water activity, pH, colour and solubility of regular and instant DSC powders are shown in Table 1. As shown in Table 1, the moisture content of regular DSC powder was 3.84%. This agreed with Babiker et al., [11], who reported that the moisture content of date seed roasted at the temperature ranging from 180°C to 220°C was between 3.58 - 3.90%. However, the moisture content of instant DSC powder was significantly higher ($p<0.05$) at 6.28%. This was expected as Deotale, et al. [18] reported that the moisture content of freeze-dried coffee powder was 6.91%.

Table 1. Comparison between regular and instant date seed coffee (DSC) powder in terms of moisture content, water activity, pH, colour, and solubility.

DSC Powder	Moisture content (%)	Water activity	pH	Colour properties			Solubility (s)
				L*	a*	b*	
Regular	3.84± 0.06**	0.31± 0.32**	5.77± 0.05**	34.63± 0.18**	5.88 ± 0.04**	5.90 ± 0.04**	80 ±14.14**
Instant	6.28± 0.00**	0.39± 0.03**	6.16± 0.04**	38.48± 0.01**	9.41 ± 0.07**	11.46± 0.03**	11 ± 1.40**

*L*lightness (ranging from 0 to 100), a*green to red (ranging from -60 to +60), b*blue to yellow (ranging from -60 to +6)*
*Note. **Significant variations ($p<0.05$)*

The water activity of regular and instant DSC powder was 0.31 and 0.39, respectively. These values were lower than the minimum water activity required for growth of spoilage organisms such as mould (0.80), yeasts (0.88), and bacteria (0.91), which guarantee the storage stability of DSC [13]. However, control measures should be taken to an extremely dry food product at a_w < 2 for lipid oxidation [19].

The pH of brewed coffee from regular and instant DSC powder was 5.77 and 6.16, respectively. Similarly, Mursalin et al. [20] reported that the pH of ground coffee prior to making instant coffee was in the range of 5.50-5.60. They discovered that roasting could reduce the pH of coffee due to the release of evaporated acids. The pH was slightly below the recommended pH range for a well-balanced cup of coffee, which is between 6.5 and 7.5 [19].

The L*, a* and b * value of instant DSC powder was significantly higher ($p>0.05$) than that of regular DSC powder. To further characterize the colour difference, the classification system based on ΔE proposed by Cserhalmi et al. [21] was used. Based on this classification, ΔE can be categorized as not noticeable (0.0.5), slightly noticeable (0.5-1.5), noticeable (1.5-3), and well visible (>3). It was found that hot extraction and freeze-drying of soluble solids resulted in well-visible colour difference between regular and instant DSC powder with a ΔE value of 7.6. This result agreed with Anandharamakrishnan, [22], who reported that freeze-drying resulted in lighter coffee powder.

The solubility of the ingredients is the most significant consideration when creating an instant beverage. A small amount of powder is recommended for an instant beverage in which water-soluble extracts are important. As shown at Table 1, instant DSC powder has higher solubility (11 s) ($p<0.05$) than regular DSC powder GP (80 s). As shown in Table 1 instant DSC powder was dissolved completely and appeared darker than regular DSC leaving almost no coffee sediment at the bottom. It is known that freezing contributes to the porosity of powders by allowing ice crystals to escape during freeze drying [14]. Also, a highly fine porosity structure was reported in coffee extract dried under vacuum, air, and contact freezing [18].

Nutritional Composition and Antioxidant Activity of Date Seed Coffee (DSC) Powder

The nutritional composition and antioxidant properties of regular and instant DSC powder was shown in Table 2. It was found that there was no significant difference ($p>0.05$) in the amount of ash, fat, protein, and carbohydrate between regular and instant DSC powder. However, the amount of protein in DSC powder in the present study was almost half of unroasted date seed reported by Sadiq et al. [23]. It was postulated that roasting could lead to an abrupt reduction in protein content normally at 220 °C due to the thermal breakdown of protein structure. This was supported by Al Jaloued et al. [24], who reported that the protein concentration decreased with roasting temperature from 14.09 to 8.84% at 180 °C and 220 °C, respectively for 20 min. Overall, it can be concluded that freeze-drying in the production of instant coffee was proven to retain its nutritional content.

Table 2. Comparison between regular and instant date seed coffee (DSC) powder in terms of nutritional composition (%) and antioxidant properties.

DSC powder	Ash	Crude fat	Crude protein	Total carbohydrate	DPPH (%)	TPC (GAE/100 g)
Regular	1.51 ± 0.11	9.97 ± 0.20*	6.32 ± 0.04	78.36 ± 0.24	82.15 ± 2.06*	295 ± 5.96*
Instant	1.41 ± 0.16	9.95 ± 0.31*	6.37 ± 0.07	78.08 ± 0.39	77.70 ± 0.74*	233.54 ± 0.36*

DPPH: the free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) method
TPC: Total phenolic content
*Note. *Significant variations ($p<0.05$)*

As shown in Table 2, the total phenolic content (TPC) in the extract of regular DSC was higher (295 GAE/100 g) ($p<0.05$) than that of instant DSC (233.54 GAE/100 g). Similarly, the antioxidant activity of the extract from regular DSC was higher (82.15%) ($p<0.05$) than that of instant DSC (77.7%) as measured by the free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH) method. These results indicated that there could be a decline in the contents of antioxidants due to degradation of certain compounds. This could be resulted from long duration of drying as the freeze dryer's low pressure needs to be maintained throughout the process [25]. To overcome such a problem in freeze drying, encapsulation of soluble coffee extract prior to freeze drying was reported to retain phenolic compounds [26] but requires additional steps in the process as well as ingredients as the coating material. Likewise, spray-dried coffee was identified to have better retention of antioxidants than freeze-dried coffee but requires addition of other ingredient in the liquid soluble coffee to increase its solid content prior to drying [12].

Identification of volatile compound by GC-MS

The amount and variety of volatile compounds identified in the headspace of regular DSC and instant DSC by HS-SPME/GC-MS were shown in Figure 1(A), 3(B), Table 3 and Table 4, respectively. The volatile profile of regular DSC and instant DSC powder was 28 and 40 volatile compounds respectively. Therefore, it was proven that freeze drying process in the production of instant coffee was able to retain more odour and/or flavour of instant DSC powder. For example, Dong et al. [27] reported that freeze-drying techniques retained the odour constituents and aromatic character of roasted coffee beans and quinic acid, a key organic acid associated with coffee quality.

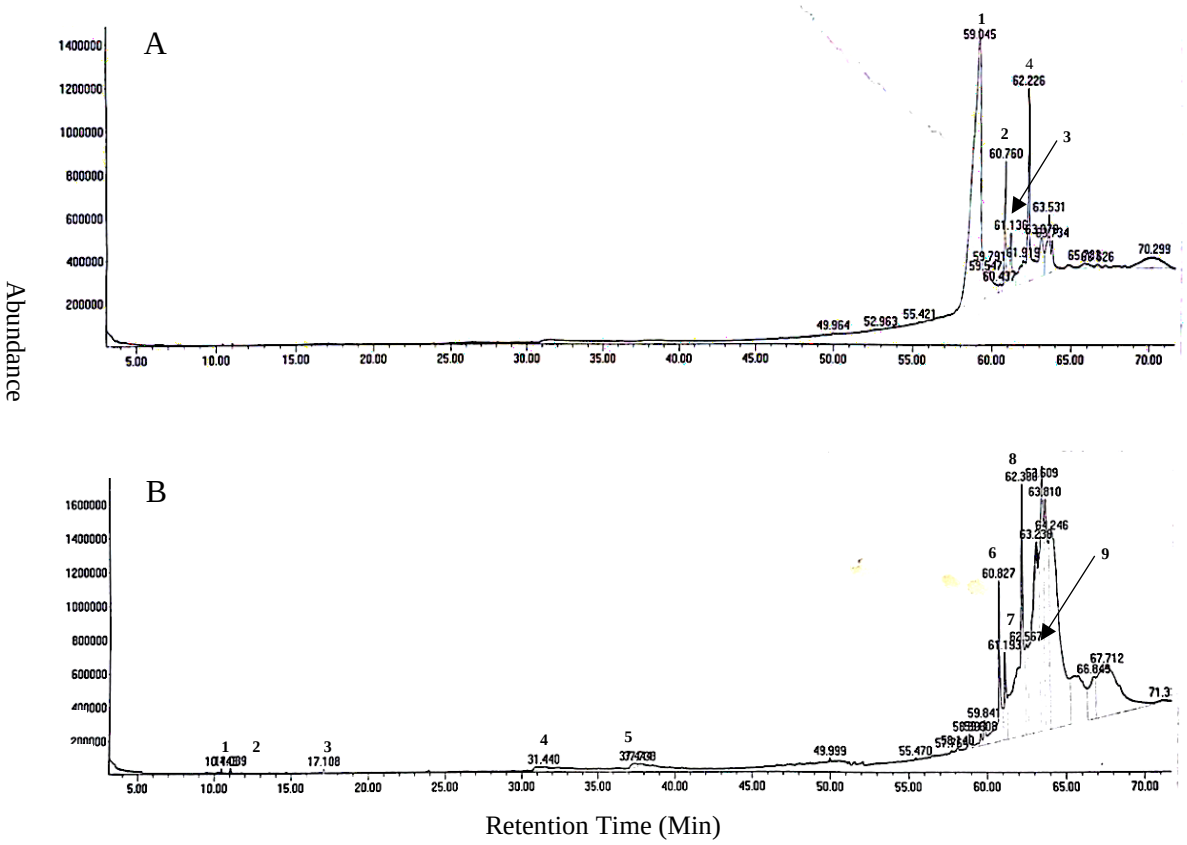

Figure 1. Representative GC-MS chromatograms of volatiles compounds derived rom regular (A) and instant (B) DSC powder.

A – 1: Dodecanoic acid, 1,2,3-propanetriyl ester, 4-Nitrophenyl laurate, 2: γ-Sitosterol, β-sitosterol, 3: Stigmasta-5,24(28)-dien-3-ol,eta.,24Z)-, pregn-5,7-diene-3-ol-20-one , 4: 9,19-Cyclolanost-24-en-3-ol, (3.beta.-), 9,19-Cyclolanost-24-en-3-ol, acetate, (3.beta.)-

B – 1:Hentriacontane, octacosane, heneicosane, 2: 2, 4-Di-tert-butylphenol, 3: Hexacosane, octacosaine, pentacosane, 4: Oleic acid, palmitoleic acid, 5: 6-Octadecenoic acid, 9-Octadecenamide, 6: γ-Sitosterol, β-sitosterol, 7: Stigmasta-5,24(28)-dien-3-ol,eta.,24Z)-, androst-5,15-dien-3ol acetate, pregnane-3, 20-dione, 11-hydroxy-,(5.alpha.,11.beta.)-, 8: 9,19-Cyclolanost-24-en-3-ol, (3.beta.-), lanosterol, 9: Colchiceine, N-desacetyl-N-TFA-5Alpha-cyano-3-methoxymethylenecholestane, (E)-, 3-Methoxyandrosta[16,17-b]furan-2'-imine, 3'methylene-N-cyclohexyl-

Based on Figure 1, there were 4 peaks indicating major compounds such as laurin, phytosterols, cycloartenol acetate, isofucosterol in regular DSC powder. In contrast, there were 9 peaks indicating volatile compounds such as hentriacontane, octacosane, heneicosane 2,4-Di-tert-butylphenol, oleic acid, palmitoleic acid, petroselinic acid, campesterol, and furan in instant DSC powder, which were absent in regular DSC powder. Phytosterols, cycloartenol acetate, isofucosterol were present in both regular and instant DSC powder.

Hentriacontane, octacosane, heneicosane, hexacosane, pentacosane, oleic acid, palmitoleic acid, androst-5,15-dien-3ol acetate, 3-Methoxyandrosta [16,17-b]furan-2'-imine, 3'methylene-N-cyclohexyl-, benzo[h]quinoline, 2,4-dimethyl- were the important volatile compounds associated with roasted date seed powder that were absent in the regular DSC powder but successfully detected in instant DSC powder. Hentriacontane, for example, is a 31-carbon-atom straight-chain aliphatic alkane with pharmacological activity, including anticancer and antitubercular properties [28]. Fatty acids such as oleic acid and palmitoleic acid serve numerous vital purposes in the body, mainly the storage of energy. Furans detected in instant DSC powder are the most numerous volatiles responsible for the sweet, toasted scent of coffee. They are formed by the thermal decomposition of carbohydrates, ascorbic acid, or unsaturated fatty acids during roasting. The volatile compound of sterols was the most abundant in both regular and instant DSC powder which were γ-Sitosterol, β-Sitosterol, Stigmasta-5,24(28)-dien-3-ol,eta.,24Z)-, and 9,19-Cyclolanost-24-en-3-ol, (3.beta.). β-Sitosterol for example, is an effective phytosterol as a cholesterol-lowering agent. The compound can prevent cholesterol from being absorbed into the bloodstream by competing for intestinal absorption and reduce the risk of heart disease caused by the excessive absorption of cholesterol, such as colon cancer, breast cancer, and prostate cancer [29].

Table 3. Volatile compounds detected in the headspace of regular DSC powder.

Peak No	Rt (min)	Compounds	Area (%)	Qualitative
1	52.93	4-(-Hydroxyphenyl)-4-methyl-2-pentanone, TMS derivative	0.06	43
		N-Methyl-1-adamantaneacetamide		43
		1,2-Bis(trimethylsilyl)benzene		43
2	55.42	Arsenous acid, tris(trimethylsilyl) ester	-0.14	43
		Methyltris(trimethylsiloxy)silane		47
3	59.05	Dodecanoic acid, 1,2,3-propanetriyl ester	54.38	91
		4-Nitrophenyl laurate		38
4	59.55	2,4-Cyclohexadien-1-one, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-	1.41	46
		1,4-Bis(trimethylsilyl)benzene		41
		1,2-Bis(trimethylsilyl)benzene		41
5	59.79	.1-(4-Nitrophenyl)piperazine	3.52	49
		Benzamide, 3,4-dimethoxy-N-(2-cyanophenyl)-		35
6	60.44	4-tert-Butylphenol, TMS derivative	0.52	47
		4-tert-Octylphenol, TMS derivative		47
		Thymol, TMS derivative		47
7	60.76	gamma.-Sitosterol	5.33	99
		.beta.-Sitosterol		84
8	61.14	Stigmasta-5,24(28)-dien-3-ol,eta.,24Z)-	3.33	97
		Pregn-5,7-diene-3-ol-20-one		55
9	61.92	1,2-Benzisothiazol-3-amine, TBDMS derivative	3.59	50
		Tetrasiloxane, decamethyl-		47
10	62.23	9,19-Cyclolanost-24-en-3-ol, (3.beta.-)	10.02	99
		9,19-Cyclolanost-24-en-3-ol, acetate, (3.beta.)-		91
11	63.07	2-Methyl-7-phenylindole	4.47	30
		1,2-Benzenediol, 3,5-bis(1,1-dimethylethyl)-		30
12	63.53	2'Hydroxy-5'-methylacetophenone, TMS derivative	4.61	46
13	65.78	2'-Hydroxypropiophenone, TMS derivative	1.13	49
14	70.299	Cyclotrisiloxane, hexamethyl-	5.95	43

Table 4. Volatile compounds detected in the headspace of instant DSC powder.

Peak No.	Rt (min)	Compounds	Area (%)	Qualitative
1	10.44	Hentriacontane	0.05	87
		Octacosane		80
		Heneicosane		80
2	11.04	2,4-Di-tert-butylphenol	0.06	94
3	17.11	Hexacosane	0.04	86
		Pentacosane		72
4	31.44	Oleic acid	0.40	64
		Palmitoleic acid		64
5	37.44	6-Octadecenoic acid, (z)-	0.27	64
		9-Octadecenamide, (z)-		55
6	50.00	2,6,10-Decatrienoic acid, 3,7,11-trimethyl-, ethyl ester, (z,z)	0.05	46
		Cyclopropanecarboxylic acid, hydrazide, N2-cyclooctylideno-		30
		2-Ethylacridine		15
7	55.47	4-(4-Hydroxyphenyl)-4methyl-2-pentanone, TMS derivative	0.06	43
		1,2-Bis(trimethylsilyl)benzene		43
		1,2-Benzisothiazol-3-amine, TBDMS derivative		43
8	57.76	Thymol, TMS derivative	-0.13	49
		4-tert-Butylphenol, TMS derivative		47
		Acetamide, N-[4-(trrymethylsilyl)phenyl)]		46
9	58.14	Tris(tert-butyldimethylsilyloxy)arsane	0.09	38
10	58.89	Campesterol	0.35	53
11	59.61	1,2-Benzenediol, 3,5-bis(1,1-dimethylethyl)-	0.42	46
12	59.84	N-(5-Amino-1,3-benzothiazol-2-yl) acetamide	0.61	49
		Methanamine, N-(diphenylethenylidene)-		46
		1-(4-Nitrophenyl)piperazine		46
13	60.83	gamma.-Sitosterol	4.60	99
		beta.-Sitosterol		95
14	61.19	Stigmasta-5,24(28)-dien-3-ol,eta.,24Z)-	2.19	96
		Androst-5,15-dien-3ol acetate		83
		Pregnane-3, 20-dione, 11-hydroxy-,(5.alpha.,11.beta.)-		56
15	62.30	9,19-Cyclolanost-24-en-3-ol, (3.beta.-)	13.52	97
		Lanosterol		25
16	62.57	Colchiceine, N-desacetyl-N-TFA-	2.32	45
		5Alpha-cyano-3-methoxymethylenecholestane, (E)-		25
		3-Methoxyandrosta[16,17-b]furan-2'-imine, 3'methylene-N-cyclohexyl-		15
17	63.24	Dodecanoic acid, 1,2,3-propanetriyl ester	16.11	53
		Acetamide, 2,2,2-trifluoro-N-(5,6,7,9-tetrahydro-2-hydroxy-1,3,10-trimethoxy-9-oxobenzo(a)heptalene-7-yl-, (S)-		38
18	63.24	5-Acetyl-2-(3-bromo-enzoylamino)-4-methyl-thipene-3-carboxylic acid ether ester	10.16	25
19	71.33	Benzo[h]quinoline, 2,4-dimethyl-	0.32	46
		Cyclotrisiloxane, hexamethyl-		46

Table 5. Attribute-wise means, standard deviations, and 't' values of brewed coffee from commercial coffee bean and regular date seed coffee (DSC).

Attributes	Sensory scores[1] of coffee drink				'*t*' value
	Commercial coffee bean powder		Regular DSC		
	Mean	SD	Mean	SD	
Colour	6.86	1.74	7.06	1.39	-0.72^{NS}
Aroma	6.80	1.91	7.44	1.28	-2.32*
Sweetness	4.40	2.29	5.18	1.81	-2.83*
Astringency	5.72	1.76	5.46	1.81	1.25^{NS}
Bitterness	5.88	2.55	5.82	1.96	0.17^{NS}
Sediments	6.78	1.99	6.64	2.05	0.59^{NS}
Overall acceptability	6.26	2.09	6.56	1.47	-1.12^{NS}

[1] 1 = Dislike Extremely, 2 = Dislike Very Much. 3 = Dislike Moderately, 4 = Dislike Slightly, 5 = Neither Like nor Dislike, 6 = Like Slightly, 7 = Like Moderately, 8 = Like Very Much, 9 = Like Extremely.
**Significant at 0.05 level (two-tailed).*

Sensory evaluation of brewed date seed coffee (DSC)

Based on Table 5, it was confirmed that regular DSC was superior to commercial coffee bean drink in terms of aroma ($t = -2.32$, $p < 0.05$) and sweetness ($t = -2.83$, $p < 0.05$). However, there was no difference observed in terms of colour, astringency, bitterness, sediments, and overall acceptability. Therefore, it can be concluded that regular DSC is comparable with coffee brewed from coffee beans.

CONCLUSION

It was established that the solubility of DSC was increased due to the combination of hot extraction and freeze-drying of soluble coffee powder rendering it as an instant beverage. However, the long duration of freeze-drying resulted in a reduction of total phenol content and the antioxidant activity of the DSC. Nevertheless, there is no distinction between regular and instant DSC in terms of nutritional composition. The sensory evaluation revealed that regular DSC is superior to commercial coffee bean in terms of aroma and sweetness. Therefore, it was expected that the coffee drink brewed from instant DSC will give more flavour based on the profile of volatile compounds.

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