Middle East Journal of Agriculture Research
Volume: 13 | Issue: 01| Jan. – Mar.| 2024

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2024.13.1.11
Journal homepage: www.curresweb.com
Pages: 189-203

Chicory, Barley Extract, and Date Powder as a Coffee-Like Drink

Hassan I. A .Ahmed[1], Hanan A.M. Ali [2], and Ahmed H. S. Soliman[1]

[1]Horticultural Crops Technology Research Department, Food Technology Research Institute (FTRI), Agricultural Research Centre, Al Giza, 12619, Egypt.
[2]Central Lab. of Organic Agriculture, Agricultural Research Centre, Al Giza, 12619, Egypt.

Received: 30 Jan. 2024 **Accepted:** 15 March 2024 **Published:** 25 March 2024

ABSTRACT

Coffee is one of the most preferred beverages due to its flavor and aroma. However, there are many negative effects of caffeine on human health. Alternative products like chicory have become an interest to switch from caffeine to caffeine-free beverages. The present work aimed to study the production potential of coffee-like drink using chicory, barley extract, and date powders. Also, to evaluate the nutritional, chemical, and physical properties of chicory powder, other raw materials, and coffee-like drink blends (CLDB) as compared to barley extract powder. The obtained results showed that chicory powder recorded the highest content of ash and fat, while barley extract recorded the highest content of carbohydrates and protein. As for, the coffee-like blends, the process of replacing and adding chicory powder led to significant differences in the previous components. Meanwhile, the phytochemical compound contents and antioxidant activity of both chicory and barley extract powder recorded a higher content than date powder. Chicory powder recorded a high content of inulin, while it was not detected in the other raw materials. On the contrary, β-glucan was detected in the case of barley extract and not detected for chicory powder or date powder. This led to a noticeable increase in coffee-like blends of both components, according to the percentage of both chicory powder and barley extract. Moreover, the content of minerals, it was noted that the higher content of minerals in both date powder and chicory powder led to a noticeable increase with the increment of chicory powder. The organoleptic evaluation showed that there were no significant differences between the blends and the comparison sample in color characteristics, taste, and odor, While, the quality of bitterness increased significantly when the percentage of chicory powder increased, all blends were generally accepted by the panelists, except for the blend [(CLDB5) barley extract powder 43%, chicory roots powder 50%, date powder 6%, and anticaking agent1%]. Meanwhile, the microbial load of the samples under study all blends recorded values within the permissible limit. It was also noted from the obtained results that increasing the addition rate of chicory powder led to desirable changes in the color parameters of all blends under study. The study concluded that it is possible to produce a coffee-like drink free of caffeine with a coffee-like flavor using chicory, barley extract, and date powders.

Keywords: Chicory, Barley, Date, Coffee-like drink

1. Introduction

Coffee is one of the most frequently consumed beverages worldwide, although there are some concerns related to the negative aspects of its excessive consumption, to the addictive and stimulating effect of caffeine (Majcher *et al.,* 2013). In addition, it was found that too much coffee may lead to caffeine intoxication and addiction which in turn lead to symptoms related to the nervous system such as restlessness, nervousness, difficulty sleeping, agitation, muscle twitching, rambling flow of thoughts and speech, flushed face, increased heart rate, stomach upset and increased urination (Góngora-Alfaro, 2010, Hjellvik *et al.,* 2011). Coffee substitutes offer a favorable alternative to real coffee brews both from economical and healthcare points of view (Baeza *et al.,* 2017).

Corresponding Author: Hassan I. A. Ahmed, Horticultural Crops Technology Research Department., Food Technology Research Institute (FTRI), Agricultural Research Centre, Al Giza, 12619, Egypt. E-mail: ahi_20026@yahoo.com; https://orcid.org/0000-0002-0426-9424

The seeds and roots of several plants are used to make coffee substitutes because they, like coffee beans, have a high concentration of carbohydrates, proteins, and other substances with physiological action. When the seeds and roots are roasted, they often take on a color like to coffee and produce a large amount of water-soluble extract with a coffee-like flavor. These substitutes have been composed of chicory roots, malt, barley, and rye, which are preferably used in manufacturing coffee substitutes (Kanjahn and Maier, 1997).

The positive nutritional properties of coffee substitutes, i.e. high antioxidant capacity, together with the absence of caffeine can qualify these products as valuable sources of cheap and healthy coffee alternatives, contributing to dietary antioxidant intake of possible target groups like children, pregnant and breastfeeding women, as well as elderly people (Torma *et al.,* 2019). *Cichorium intybus L*. Chicory, as it is often called, is a perennial plant that is grown all over the world. Its leaves, flowers, and roots are highly valued for their culinary uses, including salads and infusions (Perović *et al.,* 2021). Historically, the ancient Egyptians cultivated chicory as a vegetable crop, medicinal plant, and even as a substitute for coffee (Judžentienė and Bŭdienė, 2008). As an appetizer, *C. intybus* is also used as a medicine for a variety of illnesses, including fever, hepatic failure, diarrhea, cough, cancer, hangovers, liver disorders, jaundice, gallstones, minor cases of chronic skin diseases, and other digestive issues (Abbasi *et al.,* 2009 and Ghaderi *et al.,* 2012).

Roasted chicory roots are by far the most consumed ones as a coffee substitute, due to the caffeine-free and pleasant taste of the resulting brew (Indzere *et al.,* 2018, and Samsonowicz *et al.,* 2019). Chicory is added as a substitute for some parts of coffee to reduce caffeine and enhance inulin in coffee. Chicory roots are a source of health-promoting biomolecules, namely inulin, a non-reducing polysaccharide of fructose with (β2-1) glycosidic linkages (Bais and Ravishankar, 2001).

It has been related to a wide variety of health-promoting properties, including prebiotics. Various studies have reported that prebiotics stimulates the growth of host-beneficial gut bacteria, such as lactobacilli and bifidobacteria for overall beneficial health (Roberfroid, 2001 Kaur and Gupta, 2002). In addition, a prebiotic may stimulate the immune system ,and decrease the levels of pathogenic bacteria in the intestine (Liu *et al.,* 2012), relieve constipation, decrease the risk of osteoporosis by increasing essential mineral absorption (Roberfroid *et al.,* 2002), especially calcium, and reduce the risk of atherosclerosis by lowering the synthesis of triglycerides and fatty acids in the liver as well as lowering their serum levels (Kaur and Gupta, 2002). The combination of roasted chicory roots and barley has provided a product with a high antioxidant capacity (Torma *et al.,* 2019).

One of the earliest cereals that humans cultivated was barley (*Hordeum vulgare* L.), which is still a significant grain crop in modern times. But barley can also be used to make alcoholic and nonalcoholic drinks, such as coffee alternative and roasted barley teas (Tatsu *et al.,* 2020).

A small portion of this grain is consumed by humans. Nevertheless, it is gaining popularity as a "functional grain" since it contains more bioactive substances, including β-glucan (4–11%), phytochemicals, soluble and insoluble dietary fibers, and other bioactive substances, including vitamins E and B-complex and minerals (Goudar *et al*., 2020). Interest in the use of barley in the food industry has increased thanks to its fiber content, especially β-glucan, which is effective in lowering blood cholesterol, glycemic index and preventing cardiovascular disease (Baik *et al.,* 2008). Anticancer, antidiabetic, immune-modulatory, anti-inflammatory, and skin protector qualities are just a few of the promising preventive and therapeutic qualities of cereal β-glucans (Clemente *et al*., 2012; Shen *et al*., 2016 and Jayachandran *et al*., 2018). The soluble fiber group, of which cereal b-glucan is a member, has significant physiological implications since it has a direct correlation with a decrease in postprandial glucose and cholesterol levels (Atanasov *et al*., 2020). The European Food Safety Authority (EFSA) and the Food and Drug Administration (FDA) of the United States have both acknowledged the health claims made by cereal b-glucan regarding blood glucose and cholesterol management (Henrion *et al*., 2019).

The most favorable and widely used sweetener is refined sugar ,which consists of sucrose. Furthermore ,increased consumption of refined sugar leads to various health problems such as diabetes, obesity, cancer, hypertension, and others. There is a need to find a healthier substitute for refined sugar (Johnson and Yon, 2010). The date fruit bears a good nutritional profile as a rich source of carbohydrates, dietary fiber, certain essential vitamins, and minerals (Ghnimi *et al.,* 2017). Moreover, it exhibits further health-beneficial effects due to the presence of different bioactive compounds such as phenolic compounds, anthocyanins, sterols, and carotenoids. Date fruits contain a high amount of sugar, ranging from 60 to 70 % by weight (El-Far *et al.,* 2019).

Date powder is a potential ingredient for supplementing bakery products as a replacer for sugar. In this regard, date powder has been used for the development of various food products as a sugar replacer in dairy desserts (Djaoud *et al.,* 2020), healthy bread (Messaoudi and Fahloul, 2020), and fiber-rich cookies (Shabnam *et al.,* 2020). These studies indicated that incorporating date powder improved the physicochemical, nutritional, functional, and sensory attributes of developed food products. The transformation of date fruit into powder could improve its handling, storage, and its use in food fortification. In addition, it offers a natural and suitable ingredient with several nutritional and functional properties (Mkadem *et al.,* 2022).

Accordingly, the main objective of this work was to study the production potential of coffee-like drinks using chicory, barley extract, and date powder.

2. Materials and Methods

2.1. Materials

Organic chicory *(Cichorium intybus*) roots were obtained from a farm in Fayoum governorate. Barley extract powder (*Hordeum vulgaris*) was obtained from ISIS for Food Production, Bilbies, Al-Sharqia governorate, Egypt. The Barley extract powder was obtained by the following process: The barley seeds were cleaned and sieved then weighted and roasted at 215-225°C, after that the roasted barley seeds were ground and then extracted at (180-190°C under vacuum at 12-15 Bar and pH 4.35-4.8). The extraction process was done using a separator and purification concentrator at 70–80°C. Followed by filtration and then dried at 250–275°C using a spray dryer, resulting in a 115–125°C powder agglomeration. Finally, it is packed in bulk warehouses and distributed using a magnet and sieve. The Agricultural Research Center, Food Technology Research Institute provided the date powder (*Phoenix dactylifera* L.), which is a blend of many date varieties. All used chemicals were of analytical grade from El-Nasr Pharmaceutical Chemicals Co., Egypt. The used solvents, DPPH (2, 2-diphenyl-1-picrylhydrazyl), Gallic acid, and Folin-Ciocalteu were purchased from Sigma Company (St. Louis, Missouri, USA).

2.2. Methods

2.2.1. Preparation of chicory powder

Chicory roots were cleaned and washed with tap water, then air dried in a hot air-circulating oven at 40Cº, followed by roasting. The roasting process was performed in a convection oven (Memmert, Cambridge, UK) at 180±20º, for 60 min. After roasting, chicory root powder was cooled down (37±5°C), then ground and sieved to obtain a fine powder of chicory root powder (200 μm) in Cyclone Mill. Dried chicory root powder samples were packed in laminate sacks of PPE packing material (10 mm) and kept at room temperature.

2.2.2. Preparation of coffee drink substitute blends

Coffee-like drink blends were prepared by substituting barley extract powder, used as a control sample, (100% barley extract powder, 83%, 73%, 63%, 53%, and 43%) with different levels of chicory roots powder at (0,10,20, 30, 40 and 50%) and date powder at (6%), respectively, also, anticaking agent (Silicon dioxide) was added at 1% Table (1).

Table 1: Different blends of coffee-like drinks

Treatments	Barley extract powder	Chicory roots powder	Date powder	Anticaking agent
Control	100	0	0	0
CLDB (1)	83	10	6	1
CLDB (2)	73	20	6	1
CLDB (3)	63	30	6	1
CLDB (4)	53	40	6	1
CLDB (5)	43	50	6	1

CLDB: Coffee-like drink blends.

2.3. Analytical methods

2.3.1. Chemical analysis

Raw materials were subjected to the following chemical determinations: Moisture content, protein content, fat content, and ash content according to the methods (AOAC, 2012), while total carbohydrate contents were estimated by difference.

2.3.2. Total sugars and reducing sugars.

Total sugars and reducing sugars were determined according to the methods of AOAC, (2012).

2.3.3 Determination of Inulin

Raw materials and coffee substitute blend samples were subjected to inulin content determination according to Winton and Winton (1958).

2.3.4. Total phenolic compound content (TPC) measurement

According to Singleton *et al.* (1999), the Folin-Cicalteau method was used to measure total phenolic compounds (TPC). A standard curve was prepared expressing the results as mg gallic acid equivalents (GAE)/100g sample.

2.3.5. Determination of total flavonoid content

Total flavonoid content was determined by using the aluminum chloride colorimetric method as described by Chang *et al.* (2002). The results were expressed as catechin equivalent (CE) in mg/g of dried extract.

2.3.6. Determination of antioxidant activity

The antioxidant activity of free and bound phenolic extracts was measured by using 1, 1-diphenyl2-picrylhydrazyl (DPPH) scavenging as described by Hung and Morita (2009).

2.3.7. Color measurements

Color was determined at three different points of the sample with a Chroma meter (Minolta CR 400, Minolta Camera, Co., Osaka, Japan) equipped with an 8 mm measuring head and a D65 illuminate. The Chroma meter was calibrated using the manufacturer´s standard white plate. Color changes were quantified in the L*, a*, and b* color space. The International Commission on Illumination (CIE) parameters L*, and b* were measured with a (Minolta CR 400, Minolta Camera, Co., Osaka, Japan). The calorimeter was calibrated with a standard white ceramic plate (L = 95.97, a = - 0.13, b = - 0.30) before the reading. Corresponding L* value (lightness of color from zero (black) to 100 (white); a* value (degree of redness (0–60) or greenness (0 to -60); and b* values (yellowness (0–60) or blueness (0 to - 60) were measured for all the samples. Meanwhile, chroma distinguishing between vivid and dull colors was calculated according to Abonyi *et al.* (2002) by the following equations: - $C^*=\sqrt{a^2 + b^2}$.

2.3.8. Determination of β-Glucan

β-glucan was determined in raw materials and different Coffee-like drink blends according to the method described by Carr *et al.,* (1990). β- Glucan assay: The assay uses commercial cellulase (*P. funiculosum*) from (Sigma C 0901) heat-treated to remove contaminating amylolytic activity as previously described by Bamforth (1983).

2.3.9. Determination of mineral content

The mineral content of raw materials in different Coffee-like drink blends was evaluated. Potassium was estimated in the diluted solution of ash samples by using an Emission Flame Photometer (Model Corning 410). Other minerals (Manganese, Iron, copper, and Zinc) were determined by atomic absorption spectrophotometer-Perkin Elmer, Model 5000, Germany. According to the method of AOAC (2012).

2.4. Microbial analysis

2.4.1. Aerobic bacterial count

The FDA-described technique (2002) was followed for the aerobic bacterial count on plate agar: 48 ± 2 hours of incubation at 36 ± 1°C resulted in the counting and calculation of colony-forming units per gm or ml of data.

2.4.2. Yeast and mold counts

Yeast and mold counts were conducted using the potato dextrose agar medium. Colonies of yeasts and molds were counted and calculated per gm or ml of material on plates that were cultured at 22 to 25 °C for three to five days, according to the method described by FDA, (2002).

2.4.3. Detection and enumeration of Enterobacteriaceae

Spreading 0. l ml of each sufficient (anticipated) dilution onto the surface of the agar medium (violet red bile glucose agar) allowed us to count the other Enterobacteriaceae species present in the samples. To be counted, Enterobacteriaceae will metabolize glucose and create purple zones surrounding the colonies, according to the method described by FDA, (2002).

2.4.4. Detection and enumeration of Escherichia coli

After 24 hours at 35 degrees Celsius of incubation, 0.l ml of each sufficient (anticipated) dilution was placed onto plates of sorbitol MacConkey agar medium to count the amount of Escherichia coli present in the samples. On MacConkey Agar with Sorbitol, *E. coli* grows as colorless colonies, according to the method described by FDA, (2002).

2.4.5. Detection and enumeration of Salmonella typhimurium

Before being incubated for 24 hours at 35 °C, each sample (25 g) was aseptically mixed with 225 ml of sterile buffer peptone water. For 72 hours, selenite cysteine broth was incubated at 35 C after a mixture ranging from one to ten milliliters was added. Agar plates containing *Shigella* and *Salmonella* were streaked and then incubated for 24 hours at 35 °C. The FDA's technique, (2002), describes Salmonella typhimurium development as amorphous colonies with dark cores.

2.5. Sensory Evaluation

Sensory attributes (taste, color, odor, bitterness, and overall palatability) of five coffee-like drink blends and barely extract as a control sample were evaluated according to Lindley *et al.* (1993) method using ten members from Horti. Crops Tech. Res. Dept., Food Tech. Research Institute, Agricultural Research Center, Giza, Egypt.

2.6. Statistical Analysis

Statistical analysis of the results (three replicates for each sample, until otherwise stated) was carried out using a one-way analysis of variance (ANOVA) under a significant level of 0.05 using the statistical program CoStat (Ver. 6.400) according to Steel *et al.* (1997). To ascertain the significance among means of different samples, an LSD test was applied.

3. Results and discussion

3.1. Chemical constituents of raw materials and different coffee-like drink blends

The chemical composition of chicory root powder, barley extract powder, dried date powder, and their blend samples are shown in Table (2). The chicory root powder content of protein and fat represented 5.60 and 1.60%, respectively. This result is in agreement with the result obtained by Jurgonbski *et al.* (2011) who declared that the protein and fat content of chicory root extract reached 5.61 and 1.73%, respectively. The same table's data revealed ash content recorded at 4.10%, which is in the range reported by Bokić *et al.* (2022) and Abo Taleb *et al.* (2017) who found that ash content in chicory roots ranged from %3.59 to 5.22%. The same data demonstrated that total carbohydrate reached 81.15%, according to Zarroug *et al*. (2016) and Nwafor *et al*. (2017) chicory root contain 70.43-89.41% of total carbohydrate.

Table 2: Chemical constituents of raw materials and different coffee-like drink blends

Materials and Blends	Moisture content %	Ash content %	Fat content %	Protein Content %	Total carbohydrate %
Chicory root powder	$7.55^{b}\pm0.61$	$4.10^{a}\pm0.13$	$1.60^{a}\pm0.11$	$5.60^{b}\pm0.15$	$81.15^{a}\pm0.55$
Barley extract powder	$6.16^{c}\pm0.21$	$2.27^{b}\pm0.21$	$0.54^{c}\pm0.09$	$9.12^{a}\pm0.31$	$81.90^{a}\pm0.39$
Dried date powder	$14.69^{a}\pm0.86$	$1.96^{c}\pm0.10$	$0.96^{b}\pm0.09$	$2.01^{c}\pm0.13$	$80.39^{a}\pm0.77$
Coffee-like drink blends					
CLDB (1)	$6.72^{c}\pm0.15$	$2.41^{d}\pm0.09$	$0.65^{d}\pm0.04$	$8.19^{a}\pm0.15$	$81.95^{a}\pm1.11$
CLDB (2)	$6.88^{b}\pm0.11$	$2.54^{d}\pm0.12$	$0.76^{cd}\pm0.06$	$7.85^{b}\pm0.11$	$81.92^{a}\pm0.98$
CLDB (3)	$7.01^{b}\pm0.18$	$2.76^{c}\pm0.06$	$0.87^{bc}\pm0.05$	$7.48^{c}\pm0.29$	$81.83^{a}\pm1.05$
CLDB (4)	$7.16^{a}\pm0.10$	$2.93^{b}\pm0.08$	$0.96^{ab}\pm0.09$	$7.15^{d}\pm0.12$	$81.74^{a}\pm1.23$
CLDB (5)	$7.29^{a}\pm0.21$	$3.15^{a}\pm0.11$	$1.07^{a}\pm0.07$	$6.78^{e}\pm0.15$	$81.64^{a}\pm1.01$

CLDB: Coffee-like drink blends
*Values are means of three replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

On the other hand, barley extract powder had total carbohydrates, ash, and protein values of 81.90%, 2.27, and 9.12, respectively. These findings fall within the range that Hlisnikovský *et al.* (2019) provided, demonstrating that the range of barley protein content was 8.21% to 14.36%. Furthermore, barley's ash percentage ranged from 1.6 to 2.1%, according to Adhikari *et al.* (2016). However, (Das and Kaur, 2016) revealed that barley contains an 81.80% total carbohydrate content. However, compared to existing literature, which reported 2-3% fat content, barley's fat amount (0.54%) was lower (Das and Kaur, 2016). The interplay of cultivar-specific features, meteorological circumstances, and farming practices alters the quality and chemical content of barley grain (Biel *et al.,* 2020). Data in Table (2) revealed that the dried date powder's protein, fat, ash, and total carbohydrate content were, respectively, 2.01, 0.96, 1.96, and 80.39%. The present findings are consistent with the findings of Rambabu *et al.* (2020), which indicated that the chosen kinds of date fruit had protein and ash levels between 2.15–3.12% and 1.37–1.97%, respectively. According to Mohamed *et al.* (2014), date types vary greatly in their fat and total carbohydrate contents, which ranged from 1.71-2.06% and 78.73-80.41%, respectively.

From the data in Table (2), it could be observed that by increasing the chicory addition percent in the coffee substitute blend samples the moisture, ash, and fat content increased significantly. This increment could be due to the higher initial content of those constituents in chicory root powder than barley extract powder and dried date powder, recording the highest values of 7.29, 3.15 and 1.07%, respectively, for the sample containing 50% chicory root powder. However, it could be noticed that the protein content of the coffee substitute blend samples decreased significantly by increasing chicory percent in the coffee substitute blend samples reaching 6.78% in the sample containing 50% chicory root powder. This reduction could be due to the low initial content of protein in chicory root powder. On the other hand, no significant change was observed in the total carbohydrate content for all coffee substitute blend samples.

3.2. Phytochemical components and antioxidant activity of raw materials and different coffee-like drink blends

Due to their potent in vitro and in vivo antioxidant activity, ability to scavenge free radicals, stop radical chain reactions, and ability to scavenge metals, phenolic compounds have attracted the attention of food and medical specialists. Consuming phenolics has been linked to a lower risk of cancer and cardiovascular disease (Zhao and Moghadasian, 2008). The phytochemical components and antioxidant activity of chicory root powder, barley extract powder, dried date powder, and different coffee-like drink blends were determined and presented in Table (3). It could be noticed that total phenolic compounds (TPC), total flavonoids (TFC), and antioxidant activity for chicory root powder recorded 10.45 mg GAE/g, 5.33 mg CE\g, 87.82%, respectively. These results were near the range reported by Singh and Chahal (2019) who investigated the bio-activities and chemical composition of roasted *C. intybus* roots and found that the TPC, TFC, and DPPH of chicory extracts ranged between 0.68-10.13 mg GAE/g, 0.73-8.8 mg CE /g and 39.75-95.32%, respectively.

Table 3: Phytochemical components and antioxidant activity of raw materials and different coffee-like drink blends

Materials and Blends	TPC mg GAE\g	TFC mg CE\g	Antioxidant activity %
Chicory root powder	10.45^{b}±0.88	5.33^{b}±0.17	87.82^{a}±1.61
Barley extract powder	17.76^{a}±0.60	6.29^{a}±0.20	87.39^{a}±1.62
Dried date powder	4.65^{c}±0.12	0.24^{c}±0.04	65.93^{b}±1.83
Coffee-like drink blends			
CLDB (1)	15.92^{a}±1.21	5.67^{a}±0.36	84.91^{a}±4.55
CLDB (2)	15.33^{a}±1.00	5.58^{a}±0.37	85.27^{a}±4.06
CLDB (3)	14.72^{a}±1.81	5.53^{a}±0.43	85.31^{a}±3.07
CLDB (4)	13.90^{a}±0.95	5.46^{a}±0.07	84.66^{a}±2.15
CLDB (5)	13.20^{a}±0.90	5.35^{a}±0.13	85.18^{a}±3.55

CLDB: Coffee-like drink blends
TPC: total phenol content, TFC: Total flavonoid content
*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

Denev *et al.* (2014) noted that the different amounts of total phenolic content depend on the chicory culture, the harvest date, and the extraction solvent The powdered barley extract had 17.76 mg GAE/g and 6.29 mg CE\g of total phenolic and flavonoid content, respectively. Barley extract powder exhibited a DPPH radical scavenging activity of 87.39%. Consequently, barley's high phenolic component content reveals that it could be a great dietary source of natural antioxidants with antiradical and antiproliferative properties for the prevention of disease and the promotion of health (Madhujith and Shahidi, 2007; Zhao *et al.,* 2008). Also, Omwamba and Hu (2010) reported that the antioxidant activity of barley was measured as (DPPH) and found to range from 70.67 to 90.39%. Barley tea possesses strong antioxidant properties, partly due to the presence of phenolic compounds (Etoh *et al.,* 2004). Meanwhile, dried date powder recorded 4.65, 0.24 mg/ml, and 65.93% for TPC, TFC, and DPPH, respectively. Previous research illustrated that date powder contained 4.08, 0.25-0.62mg/g of total phenol and total flavonoid contents, respectively, (Jrad *et al.,* 2019 and Sohail *et al.,* 2019). Furthermore, Al-Harrasi *et al.* (2014) assessed the nutritional content and performed an antioxidant analysis on 22 varieties of date palm (*Phoenix dactylifera*) fruit kinds that were gathered from different parts of the Sultanate of Oman. They discovered that the antioxidant activity varied from 40 to 86% based on the date variety and location. The data in the same table showed that adding more chicory root powder to the coffee-like drink mixes had no discernible impact on TPC. For TFC and antioxidant activity, an identical result was seen across all samples.

3.3. Total and reducing sugars, inulin, and β-glucan contents of raw materials and different coffee-like drink blends.

The total and reducing sugar content of chicory root powder, barley extract powder dried date powder, and different coffee-like drink blends were tabulated in Table (4). Chicory root powder recorded 39.11 and 6.49% for total sugar and reduced sugar contents, respectively. Total sugar content is in the range reported by Gholami *et al.* (2018) for chicory roots under vermicompost and humic acid treatments ranging from 21.12 to 79.80% while reducing sugar is higher than the range reported by them which was from 2.86 to 3.09%. Barley extract total and reducing sugars contents recorded 8.96 and 7.70%, respectively. The major components of the solid content of dried date are sugars. From the data shown in Table (4), it could be noticed that the total and reducing sugars of dried date powder were recorded at 68.97 and 57.25%, respectively.

Table 4: Total and reducing sugars, inulin, and β-glucan contents of raw materials and different coffee-like drink blends.

Materials and Blends	T. sugars%	T.R.S%	Inulin %	β- Glucan g/100g
Chicory root powder	39.11^{b}±1.58	6.49^{b}±0.23	23.54	ND
Barley extract powder	8.96^{c}±0.08	7.70^{b}±0.26	ND	8.02
Dried date powder	68.97^{a}±1.19	57.25^{a}±1.05	ND	ND
		Coffee-like drink blends		
CLDB (1)	15.16^{e}±1.53	10.22^{a}±1.26	2.34^{e}±0.07	6.63^{a}±11.68
CLDB (2)	18.23^{d}±1.42	10.31^{a}±1.19	4.67^{d}±0.25	5.86^{b}±12.01
CLDB (3)	21.22^{c}±1.02	10.33^{a}±0.85	7.07^{c}±0.11	5.04^{c}±16.01
CLDB (4)	24.31^{b}±1.11	10.36^{a}±1.12	9.41^{b}±0.30	4.24^{d}±6.51
CLDB (5)	27.28^{a}±0.98	9.39^{a}±1.23	11.68^{a}±0.26	3.43^{e}±9.61

CLDB: Coffee-like drink blends
TRS: Total and reducing sugars; T. sugars: Total sugars
*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

These results are in agreement with those reported by Darsangi *et al.* (2020) who studied the physico-chemical and thermal properties of the date powder and found that the total and reducing sugar content of date powder reached 68.64 and 58.80%, respectively. From the data in Table (4) it could be noticed that total sugar content increased significantly by increasing chicory addition percent in the coffee substitute blend samples. This could be due to the higher initial total sugar content in chicory root powder than barley extract powder while dried date powder addition was constant (6%) in all blend samples. This led to the total sugar content in the sample containing 50% chicory powder being the highest (27.28%). Meanwhile, increasing the chicory root powder addition in the coffee-like drink blends had no significant effect on reducing sugar content.

Inulin is a polymer of fructose with β-(2-1)-glycosidic-linkage. As a prebiotic, inulin is a dietary fiber and is low in calories, making it a perfect element in diabetic nutrition (Li *et al.,* 2008). Results in Table (4) showed that the inulin content for chicory root powder was 23.45%. Chicory root inulin content after drying ranged from 18.13 to 29.02% as reported in the study by Černý *et al.* (2008) and Abo Taleb *et al.* (2017). Meanwhile, inulin was not detected in barley extract or dried date powder. Therefore, it could be observed that inulin content in coffee-like drink blends increased significantly by increasing the percentage of chicory root powder addition in all samples reaching the highest value recorded for the sample containing 50% chicory root powder.

β-glucans consumption has several physiological benefits, including lowering cholesterol, and blood pressure, reducing coronary disease risk, and improving gut flora (Izydorczyk, 2019). Data in Table (4) indicated that barley extract contained 8.02% of β-glucan. It was stated that the content of β-glucan in barley was considerably higher than that of any other cereal making up 5.0–11.0% (Guo *et al.,* 2020). The chemical composition of barley powder could be affected by several factors, such as cultivars, locations, and processing conditions (Goudar *et al.,* 2020). On the other hand, chicory root powder and dried date powder β-glucan content were not detected. Based on these findings, it could be noticed that coffee-like drink blends with higher barley extract and lower chicory root powder percentage were significantly higher in β-glucan content whereas the 10% chicory root powder sample recorded 6.63%.

3.4. Minerals content (mg/100g) of raw materials and different coffee-like drink blends

Minerals are needed for growth, metabolic functioning, and a normal plant life cycle. Additionally, environmental stresses (salinity, drought, extreme temperatures, and light conditions) affect mineral content in different ways, depending on the species or cultivar, and the specific plant organ. Furthermore, minerals are essential in human metabolism and body functions (Perović *et al.,* 2021). The mineral content of chicory root powder, barley extract powder, dried date powder, and different coffee-like drink blends was determined and presented in Table (5). Chicory root powder contains of the following minerals: Fe (0.81 mg/100g), Mn (0.18 mg/100g), Cu (0.12 mg/100g), Zn (0.26 mg/100g), and K (154.42 mg/100g).

Table 5: Minerals content (mg/100g) of raw materials and different coffee-like drink blends

Materials and Blends	K	Zn	Cu	Mn	Fe
Chicory root powder	154.42	0.26	0.12	0.18	0.81
Barley extract powder	113.18	0.21	0.03	0.13	0.56
Dried date powder	194.25	1.04	0.39	1.42	9.79
Coffee-like drink blends					
CLDB (1)	118.23	0.26	0.04	0.18	1.13
CLDB (2)	124.75	0.28	0.07	0.22	1.19
CLDB (3)	130.07	0.30	0.07	0.23	1.23
CLDB (4)	132.47	0.29	0.11	0.25	1.21
CLDB (5)	131.61	0.32	0.14	0.29	1.30

CLDB: Coffee-like drink blends

The mineral content of chicory roots for K, Zn, Cu, and Fe ranged from 103-380, 0.17-0.39, 0.07-0.36, and 0.74-1.77 mg/100g, respectively, according to Zarroug *et al.* (2016) and Nwafor *et al.* (2017) Mn had a higher value of 0.26-0.31 mg/100g. Additionally, the mineral content of barley extracts showed high levels of (K) and (Fe) at 113.18 and 0.58 mg/100g, respectively.

On the other hand, dried date powder root recorded mineral content values of K, Zn, Cu, Mn, and Fe were 194.25, 1.04, 0.39, 1.42, and 9.79 mg/100g, respectively. Cantadori *et al.* (2022) reported that the mineral content of date fruits varied between 107.40-916.00, 0.10-1.80, 0.10-2.90, 0.21-5.90, and 0.30-32.76 mg/100g for K, Zn, Cu, Mn, and Fe, respectively. Meanwhile, from the data in (Table 5), it could be noticed that the mineral content of all coffee-like drink blends increased with the increase of chicory addition. These results may be due to high chicory and date mineral contents, these results were in harmony with Nwafor *et al.* (2017) and Cantadori *et al.* (2022).

3.5. Sensory evaluation of different coffee-like drink blends

The final criterion for evaluating the quality of coffee-like drink blends was often their organoleptic characteristics. Making a comparative sensory assessment for barley extract powder with varying quantities of chicory root powder and date powder was advantageous from the consumer's point of view. The panelists assessed the treatments' overall palatability as well as their color, taste, odor, and bitterness. The obtained results are shown in Table (6)**.** In general, the analysis showed that there was no significant difference between the tested attributes (color, taste, odor) of all treatments and the control sample. The data show that the bitterness characteristic was significantly affected by increasing the amount of chicory root powder added from 10 to 50%, as the average sensory evaluation of the bitterness characteristic was 5.5 at 10% chicory powder, while the highest value was 9.5 for 50% chicory powder it was 8.92 at 0% chicory powder. Data in the same table shows that there were no significant differences in overall palatability between 10%, 20%, 30%, and 40% samples were 8.17, 8.83, 8.42, and 8.16, respectively. The lowest values of overall palatability were 7.33 and 6.16 for the control sample and 50% sample.

The bitter taste, which gives the bitterness characteristic of the product, which is similar to the bitterness found in coffee, is attributed to the addition of chicory root powder in the product. These findings are consistent with those made by Lang *et al.* (2022) who stated that ground roasted chicory roots, which contain a range of bitter sesquiterpene lactones, can substitute roasted coffee in certain cases, with the tastes appearing to be identical. Also, Nwafor *et al.* (2017) reported that Lactucin, 8-deoxylactucin, lactucopicrin, and 11ß-dihydro-derivatives are among the sesquiterpene lactones that give chicory its bitter taste. Chicory's bitterness is caused by these compounds. Due to the similarities in characteristics between the original coffee, Arabica, and chicory coffee, which is made from chicory root, chicory coffee is the most popular alternative to coffee (Indzere *et al.,* 2018).

Table 6: Sensory evaluation of different coffee-like drink blends

Blends	Color	Odor	Taste	Bitterness	Overall palatability
Control	7.66[a]±0.82	8.33[a]±0.52	8.17[a]±0.75	8.92[a]±0.20	7.33[bc]±1.03
CLDB (1)	8.33[a]±0.68	9.00[a]±0.00	8.92[a]±0.49	5.50[d]±0.84	8.17[abc]±0.58
CLDB (2)	8.16[a]±0.75	8.17[a]±0.75	8.00[a]±0.63	4.33[e]±0.52	8.83[a]±0.75
CLDB (3)	8.00[a]±1.41	9.17[a]±0.41	8.16[a]±1.47	6.33[c]±0.51	8.42[ab]±0.41
CLDB (4)	9.16[a]±0.75	8.50[a]±1.38	7.67[a]±1.50	7.17[b]±0.41	8.16[abc]±0.41
CLDB (5)	7.66[a]±0.81	8.33[a]±0.52	8.66[a]±0.51	9.50[a]±0.55	6.16[c]±0.75

CLDB: Coffee-like drink blends
*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

3.6. Microbial analysis of different coffee-like drink blends

The total aerobic bacteria count (TBC) is the most used and dependable tool for evaluating the hygienic status of food and food additives. The collected data (Table 7) indicated a slight variation in the total bacterial populations at 37ºC between those tested samples.

Table 7: Microbial analysis of different coffee-like drink blends

Microbial analysis	CLDB (1)	CLDB (2)	CLDB (3)	CLDB (4)	CLDB (5)
Total aerobic count (CFU/g)	$2.2*10^2$	$2.3*10^2$	$2.5*10^2$	$2.1*10^2$	$2.3*10^2$
Yeasts and Molds (CFU/g)	38	36	39	37	32

CLDB: Coffee-like drink blends
ND: not detected

Molds and yeasts do appear to dominate the microflora of powder samples. For treatments 10, 20, 30, 40, and 50% the levels of yeast and mold were 38, 36, 39, 37, and 32 CFU/g, respectively. In addition, it did not detect *Enterobacteriaceae*, *E. coli,* and *Salmonella*. The samples were all in compliance with the microbial limits of (NFSA Decree 1, 2021).

3.7. Color measurements of different coffee-like drink blends

Color is considered a critical factor affecting the quality of products, also. Color attributes of products might also influence consumer acceptability. Whereas L*- Lightness, b*- Yellowness, a*- Redness, chroma (vividness) values, and Heu (degree of color distribution). From Table (7), it can be observed that there was a significant difference between all color parameter values (L*, a*, b*, chroma, and hue angle). Moreover, it was observed that lightness values declined with the excess additional amount of chicory powder and the sample became lighter. However, all applied treatments show significantly higher values of L* and hº compared with the control sample.

Furthermore, the most effective sample in preserving higher L* and h° values was (CLDB 5) indicating that lighter sample (high L*) retained red color (high h°) whereas the control sample had lower L* and h°, indicating that the darker sample (low L*) and less red color (low h°). Meanwhile, a slight yellowness appeared on the blended samples. It was clear from the obtained results that the highest b* (yellowness) values were recorded for (BCD5) which was 22.07 followed by (CLDB 4), and then the (CLDB 2) sample.

It appeared from the results shown in Table (7) that the sample (CLDB 5) recorded a lower (a*) red value than the other samples and control sample. Moreover, the control sample recorded the highest values of chroma (more vivid) followed by (CLDB 1), then (CLDB 2), while the dullest yellow color was recorded for (CLDB 5). These results may be due to the use of chicory and date powders, moreover, it can be suggested that the non-enzymatic browning and pyrolysis reactions occurring during the roasting process of barley extract, which enhance the development of brown pigments, consequently give the different coffee like drink blends a darker color.

These results are in agreement with those recorded by Massini *et al. (*1990) and Mohammad *et al.,* 2019), meanwhile, these were in contrast with Ferreira *et al.* (2016) who studied the physical properties of cakes with chicory root flour and showed that increasing the content of chicory flour decreased the L* value. For a* values, cake samples with 5% chicory root flour and 10% chicory root flour were higher than control.

Table 8: Color measurements of different coffee-like drink blends

Blends	L*	a*	b*	Hue	Chroma
Control	20.52^{e}±0.12	11.21^{a}±0.09	14.32^{e}±0.08	17.14^{d}±0.15	68.70^{a}±0.02
CLDB (1)	27.46^{c}±0.03	9.24^{b}±0.02	18.43^{d}±0.01	22.74^{c}±0.02	23.87^{b}±*0.03*
CLDB (2)	27.48^{c}±0.07	8.63^{c}±0.04	20.77^{b}±0.03	66.02^{b}±0.03	21.92^{b}±0.03
CLDB (3)	25.75^{d}±0.02	9.11^{b}±0.05	20.15^{c}±0.02	66.83^{b}±0.08	22.74^{b}±0.04
CLDB (4)	36.05^{a}±0.05	8.26^{d}±0.01	21.19^{a}±0.02	67.56^{a}±0.05	19.79^{c}±0.02
CLDB (5)	35.88^{b}±0.08	7.20^{e}±0.04	22.07^{a}±0.05	68.68^{a}±0.09	13.44^{d}±0.09

CLDB: Coffee-like drink blends
*Values are means of ten replicates ±SD, means in the same column followed by the same letter are not significantly different at 0.05 level.

4. Conclusion

In conclusion, it was noticed that all blends were generally accepted by the panelists, except for the blend [(CLDB5) barley extract powder 43%, chicory roots powder 50%, date powder 6%, and anticaking agent1%]. As for, the microbial load of the samples under study, all blends recorded values within the permissible limit. It was also noted from the obtained results that increasing the addition ratio of chicory powder led to desirable changes in the color parameters of all blends under study. Finally, it could be concluded that it is possible to produce a coffee-like drink free of caffeine, rich in inulin, B-Glucan contents, and with a coffee-like flavor, using chicory powder, barley extract, and date powder.

References

Abbasi, A.M., M.A. Khan, M. Ahmad, M. Zafar, H. Khan, N. Muhammad, and S. Sultana, 2009. Medicinal plants used for the treatment of jaundice and hepatitis based on socio-economic documentation. African Journal of Biotechnology, 8(8):1643-1650.

Abo Taleb, H.M., H.A. Abd El Aziz, and A.A. Kamal El Deen, 2017. Utilization of chicory plant for supplementing some products. Curr. Sci. Int., 6(4):777-787.

Abonyi, B.I., B.I. Feng, C.G. Edwards, and J. Tang, 2002. Quality retention in strawberry and carrot purees dried with a refractance window system. J. of Food Sci., 67:1051–1056.

Adhikari, B.M., A. Bajracharya, and A.K. Shrestha, 2016. Comparison of nutritional properties of Stinging nettle (*Urtica dioica*) flour with wheat and barley flours**.** Food Science and Nutrition, 4(1): 119–124.

Al-Harrasi, A., N. Ur Rehman, J. Hussain, A. Latif Khan, A. Al-Rawahi, S.A. Gilani, M. Al-Broumi, and L. Ali, 2014. Nutritional assessment and antioxidant analysis of 22 date palm (*Phoenix dactylifera*) varieties growing in Sultanate of Oman. Asian Pac. J. Trop. Med., 7(1): 591-598.

AOAC, (Association of Official Analytical Chemists). 2012. Official Methods of Analysis Association of Official Analytical Chemists International,19th edition, Gaithersburg, Maryland, USA.

Atanasov, J., W. Schloermann, U. Trautvetter, and M. Glei, 2020. The effects of β-glucans on intestinal health. Ernahrungs Umschau, 67, 140–147.

Baeza, G., B. Sarriá, L. Bravo, and R. Mateos, 2017. Polyphenol content, in vitro bio accessibility and antioxidant capacity of widely consumed beverages. J. Sci. Food Agric., 98(4), 1397–1406.

Baik, B.K. and S.E. Ullrich, 2008. Barley for Food: Characteristics, Improvement, and Renewed Interest. J. Cereal Sci., 48:233–242.

Bais, H. and G. Ravishankar, 2001. *Cichorium intybus* L. Cultivation, processing, utility, value addition and biotechnology, with an emphasis on current status and future prospects. J. Sci. Food Agric., 81:467–484.

Bamforth, C., 1983. Penicillium funiculosum as a source of 3- glucanase for the estimation of barley β-glucan. J. Inst. Brew., 89: 391-392.

Biel, W., K. Kazimierska, and U. Bashutska, 2020. Nutritional value of wheat, triticale, barley and oat grains. Acta Sci. Pol. Zootechnica, 19(2):19–28. DOI: 10.21005/ asp.2020.19.2.03, Boki´c, J., J. Koji´c, J. Krulj, L. Pezo, V. Banjac, D. Škrobot, V. Tumbas Šaponjac, S. Vidosavljevi´c, V. Stojkov, N. Ili´c, and M. Bodroža-Solarov, 2022. Development of a novel rice-based snack enriched with chicory root: Physicochemical and sensory properties. Foods, 11(16):2393. https://doi.org/ 10.3390/ foods11162393.

Cantadori, E., M. Brugnoli, M. Centola, E. Uffredi, A. Colonello, and M. Gullo, 2022. Date Fruits as Raw Material for Vinegar and Non-Alcoholic Fermented Beverages. Foods, 11(13):1972. https:// doi.org/10.3390/foods11131972.

Carr, J., S. Glatter, J. Jeraci, and B. Lewis, 1990. Enzymic determination of β-glucan in cereal based food products. Cereal Chem., 67(3): 226-229.

Černý, I., V. Pačuta, and M. Kovár, 2008.Yield and quality of chicory (*Cichorium intybus* L.) in dependence on variety and foliar application of atonik and polybor 150. Central European Journal of Agriculture, 9(3):425–430.

Chang, C., M. Yang, H. Wen, and J. Chern, 2002. Estimation of total flavonoid content in propolis by two complementary calorimetric methods. Journal of Food and Drug Analysis, 10: 178-182.

Clemente, J.C., L.K. Ursell, L.W. Parfrey, and R. Knight, 2012. The impact of the gut microbiota on human health: an integrative view. Cell, 148:1258–1270.

Darsangi, Z.R., F. Fojan Badii, and M. Salehifar, 2020. Optimization of the production of a self-stable powder from date fruit variety 'Shahani' Agric. Conspec. Sci., 85(3):247-255.

Das, M. and S. Kaur, 2016. "Status of Barley as a Dietary Component for Human". Journal of Food and Dairy Technology, 4: 25-28.

Denev, P., N. Petkova, I. Ivanov, B. Sirakov, R. Vrancheva, and A. Pavlov, 2014. Determination of biologically active substances in taproot of common chicory (*Cichorium intybus* L.). Scientific Bulletin. Series F. Biotechnologies, 18:124-129.

Djaoud, K., L. Boulekbache-Makhlouf, M. Yahia, H. Mansouri, N. Mansouri, K. Madani, and A. Romero, 2020. Dairy dessert processing: effect of sugar substitution by date syrup and powder on its quality characteristics. Journal of Food Processing and Preservation, 44 (5): e14414. http://dx.doi.org/ 10.1111/ jfpp.14414.

El-Far, A.H., B.E. Oyinloye, M. Sepehrimanesh, M.A.G. Allah, I. Abu-Reidah, H.M. Shaheen, I. Razeghian-Jahromi, A.E. Noreldin, S.K. Al Jaouni, and S.A. Mousa, 2019. Date palm (*Phoenix dactylifera*): novel findings and future directions for food and drug discovery. Curr. Drug Discov. Technol. 16:2–10.

Etoh, H., K. Murakami, T. Yogoh, H. Ishikawa, Y. Fukuyama, and H. Tanaka, 2004. Anti-oxidative compounds in barley tea. Biosci. Biotech. Bioch., 68:2616-2618.

FDA, Food and Drug Administration. 2002. Bacteriological Analytical Manual. 9th Ed., AOAC Int., Arlington, VA, USA.

Ferreira, R.E., K.J. Park, Y.K. Chang, and R.A. Oliveira, 2016. Physical evaluation of cakes with chicory root flour used as source of inulin. Revista Brasileira de Produtos Agroindustriais, 18(2): 155-159.

Ghaderi, R., M. Zardast, M. Hosseini, B. Delgir, and M. Hassanpour, 2012. Comparison of antibacterial effect of *Cichorium intybus L.* With vancomycin, ceftriaxone, ciprofloxacin and penicillin (*in vitro*). Clinical and Experimental Pharmacology, Clin. Exp. Pharmacol., 2 (2):113.

Ghnimi, S., S. Umer, A. Karim, and A. Kamal-Eldin, 2017. Date fruit (*Phoenix dactylifera* L.): an underutilized food seeking industrial valorization, NFS J., 6:1–10.

Gholami, H., F.R. Fard, M.J. Saharkhiz, and A. Ghani, 2018. Yield and physicochemical properties of inulin obtained from Iranian chicory roots under vermicompost and humic acid treatments. Industrial Crops and Products, 123:610–616.

Góngora-Alfaro, J.L., 2010. Caffeine as a preventive drug for Parkinson's disease: epidemiologic evidence and experimental support. Rev Neurol., 50(4):221-229.

Goudar, G., P. Sharma, S. Janghu, and T. Longvah, 2020. Effect of processing on barley β-glucan content, its molecular weight and extractability. International Journal of Biological Macromolecules, 162: 1204–1216. https://doi.org/10.1016/j. ijbiomac. 2020.06.208.

Guo, T., C. Horvath, L. Chen, J. Chen, and B. Zheng, 2020. Understanding the nutrient composition and nutritional functions of high and barley (Qingke): A review. Trends in Food Science and Technology, 103:109–117. https://doi.org/10.1016/j. tifs.2020.07.011.

Henrion, M. and C. Francey, 2019. Cereal β-glucans: the impact of processing and how it affects physiological responses. Nutrients, 11, 1729.

Hjellvik, V., A. Tverdal and H. Strøm, 2011. Brief Report: Boiled coffee intake and subsequent risk for type 2 diabetes. Epidemiology, 22(3):418-421.

Hlisnikovský, L., P. Čermák, E. Kunzová, and P. Barłóg, 2019. The effect of application of potassium, magnesium and sulphur on wheat and barley grain yield and protein content. Agronomy Research, 17(5):1905–1917. https://doi.org/ 10.15159/ AR. 19. 182.

Hung, P.V., and N. Morita, 2009. Distribution of phenolic compounds in the graded flours milled from whole buckwheat grains and their antioxidant capacities. Food Chemistry, 109: 325-331.

Indzere, Z., Z. Khabdullina, A. Khabdullin, and D. Blumberga, 2018. The benchmarking of chicory coffee's production. Energy Procedia, 147:631–635.

Izydorczyk, M.S., 2019. Dietary arabinoxylans in grains and grain products. In Cereal Grain-based Functional Foods: Carbohydrate and Phytochemical Components. Royal Society of Chemistry (RSC) Publishing, RSC Publishing., Marinlit. London, United Kingdom. DOI-10.1039/9781788012799, 167-203.

Jayachandran, M., J. Chen, S.S.M. Chung, and B. Xu, 2018. A critical review on the impacts of β-glucans on gut microbiota and human health. The Journal of Nutritional Biochemistry, 61:101–110.

Johnson, R.K. and B.A. Yon, 2010. Weighing in on added sugars and health, J. Am. Diet. Assoc., J Am Diet Assoc., 110(9):1296-1299. https://doi.org /10.1016/ j.jada. 2010. 06. 013.

Jrad, Z., O. Oussaief, T. Bouhemda, T. Khorchani, and H. EL-Hatmi, 2019. Potential effects of ultrafiltration process and date powder on textural, sensory, bacterial viability, antioxidant properties and phenolic profile of dromedary Greek yogurt. International Journal of Food Science and Technology, 54: 854–861.

Judžentienė, A. and J. Bŭdienė, 2008. "Volatile constituents from aerial parts and roots of *Cichorium intybus L*. (chicory) grown in Lithuania," Chemija, 19: 25–28.

Jurgonbski, A., J. Milala, J., Jusbkiewicz, Z. Zdunbczyk, and B. Król, 2011. Composition of chicory root, peel, seed and leaf ethanol extracts and biological properties of their non-inulin fractions. Food Technol. Biotechnol., 49(1):40–47.

Kanjahn, D. and H.G. Maier, 1997. Hydroxymethylfurfural and furfural in coffee and related beverages. III. Coffee related beverages. Agricultural and food sciences, Deutsche Lebensmittel-rundschau. Corpus ID: 86293637.

Kaur, N. and A.K. Gupta, 2002. "Applications of inulin and oligofructose in health and nutrition," Journal of Biosciences, 27(7):703–714.

Lang, R., T. Lang, A. Dunkel, F. Ziegler, and M. Behrens, 2022.Overlapping activation pattern of bitter taste receptors affect sensory adaptation and food perception. Frontiers in Nutrition, 9: 1082698.

Li, D., J.M. Kim, Z. Jin, and J. Zhou, 2008. "Prebiotic effectiveness of inulin extracted from edible burdock," Anaerobe, 14(1):29–34.

Lindley, M.G., P.K. Beyts, and B. Canales, 1993. Flavor modifying characteristics of the intense sweetener meo-hesperidin dihydrochalcone. J. Food Sci., 58:592-598.

Liu, H., E. Ivarsson, J. Dicksved, T. Lundh, and J.E. Lindberg, 2012. Inclusion of Chicory (*Cichorium intybus* L.) in pigs' diets affects the intestinal microenvironment and the gut microbiota ", Applied and Environmental Microbiology, 78(12) :4102–4109.

Lukinac, J. and M. Jukić, 2022. Barley in the production of cereal-based products. Plants, 11:3519. https://doi.org/10.3390/.

Madhujith, T., and F. Shahidi, 2007. Antioxidative and antiproliferative properties of selected barley (*Hordeum vulgarae* L.) cultivars and their potential for inhibition of low-density lipoprotein (LDL) cholesterol oxidation. Journal of Agricultural and Food Chemistry, 55(13):5018–5024.

Majcher, M.A., D. Klensporf-Pawlik, M. Dziadas, and H.H. Jeleñ, 2013. Identification of aroma active compounds of cereal coffee brew and its roasted ingredients. J. Agric. Food Chem., 61, 2648–2654.

Massini, R., M. Nicoli, A. Cassarà, and C. Lerici, 1990. Study on physical and physico-chemical changes of coffee beans during roasting. note 1. Ital. J. Food Sci. 2, 123–130.

Messaoudi, A. and D. Fahloul, 2020. Physico-chemical and sensory properties of barley bread enriched by freeze dried date pomace powder. Food and Environment Safety Journal, 19(1): 69-75.

Mkadem, W., K. Belguith, M. Ben Zid, and N. Boudhrioua, 2022. Fortification of traditional fermented milk "lben" with date powder: physicochemical and sensory attributes. Eng. Proc., 19, 43. https://doi.org/10.3390/ ECP2022-12618.

Mohamed, R.M.A., A.S.M. Fageer, M.M. Eltayeb, A. Isam and A.I.A.M. Mohamed, 2014. Chemical composition, antioxidant capacity, and mineral extractability of Sudanese date palm (*Phoenix dactylifera L.*) fruits. Food Science and Nutrition, 2(5):478-489.

Mohammad, F., A.Y. Yus, M.A. Alhussein, A. Russly, L.C. Nyuk, M. Esraa, and S.C. Lee, 2019. Effect of the roasting conditions on the physicochemical, quality and sensory attributes of coffee-like powder and brew from defatted palm date seeds. Foods, 8(61)1-19.

NFSA, National Food Safety Authority. NFSA Decree (1) 2021. Technical binding rules for microbial standards and penetration of food stuffs, part (flours and starches including soybean powder). Egyptian Chronical, Number 57, Subsequent (A), 31 march, pp:54-62.

Nwafor, I.C., K. Shale, and M.C. Achilonu, 2017. Chemical composition and nutritive benefits of chicory (*Cichorium intybus L.*) as an ideal complementary and /or alternative livestock feed supplement. Hindawi, (Article ID 7343928), 1–11. https://doi.org/10.1155/2017/7343928.

Omwamba, M. and Q. Hu, 2010. Antioxidant activity in barley (*Hordeum vulgare* L.) grains roasted in a microwave oven under conditions optimized using response surface methodology. Journal of Food Science, 75(1): C66-C73.

Perović, J., V.T. Šaponjac, J. Kojić, J. Krulj, D.A. Moreno , C. García-Viguera , M. Bodroža-Solarov, and N. Ilić, 2021. Chicory (*Cichorium intybus* L.) as a food ingredient –Nutritional composition, bioactivity, safety, and health claims: A review. Food Chemistry, 336(2):127676.
doi: 10.1016/j. food chem., 2020.127676.

Rambabu, K., G. Bharath, B.F. Abdul Hai, S.W. Hasan, H. Taher, and H.F.M. Zaid, 2020. Nutritional quality and physico-chemical characteristics of selected date fruit varieties of the United Arab Emirates. Processes, 8(3):256.

Roberfroid, M.B., 2001. "Prebiotics: preferential substrates for specific germs?. American Journal of Clinical Nutrition, 73(2): 406- 409.

Roberfroid, M.B., J. Cumps, and J.P. Devogelaer, 2002. Dietary chicory inulin increases whole-body bone mineral density in growing male rats. Journal of Nutrition, 132(12):3599–3602.

Samsonowicz, M., E. Regulska, D. Karpowicz, and B. Lèsniewska, 2019. Antioxidant properties of coffee substitutes rich in polyphenols and minerals. Food Chem., 278, 101–109.

Shabnam, S., A.H. Dar, M.B. Aga, and S.A. Khan, 2020. Effect of date powder and peach pomace powder on the microstructure and functional attributes of cookies. Journal of Postharvest Technology, 8(3): 37-49.

Shen, R.L., Z. Wang, J. L. Dong, Q.S. Xiang, and Y.Q. Liu, 2016. Effects of oat soluble and insoluble β-glucan on 1, 2- dimethylhydrazine-induced early colon carcinogenesis in mice. Food and Agricultural Immunology, 27:657–666.

Singh, R., and K.K. Chahal, 2019. *Cichorium intybus* L. from India: GC-MS profiling, phenolic content and *in vitro* antioxidant capacity of sequential Soxhlet extracted roasted roots. Brazilian Archives of Biology and Technology. Vol.62:
http://dx.doi.org/10.1590/ 1678-4324-2019180370.

Singleton, V.L., R. Orthofer, and R.S. Lamuela-Raventós, 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin- Ciocalteau Reagent. Methods Enzymol, (299): 152–178.

Sohail, A., A. Rafique, K.S. Abbasi, and M. Arif, 2019. Comparative impact of drying methods on phytochemical and antimicrobial activities of date fruit powders. Pakistan Journal of Agricultural Research, 32(1):1-7.

Steel, R., J. Torrie, and D. Dickey, 1997. Principles and procedures of Statistics: Biometrical Approach, 3rd ed., McGraw-Hill, New York, NY.

Tatsu, S., Y. Matsuo, K. Nakahara, T. Hofmann, and M. Steinhaus, 2020. Key odorants in Japanese roasted barley tea (Mugi-Cha)-differences between roasted barley tea prepared from naked barley and roasted barley tea prepared from hulled barley. J. Agric. Food Chem., 68:2728−2737.

Torma, A., C.S. Orbán, Z.S. Bodor, and C.S. Benedek, 2019. Evaluation of sensory and antioxidant properties of commercial coffee Substitutes. Acta Alimentaria, 48 (3), 297–305 DOI: 10.1556/066. 48.3.3.

Winton, A.L. and K.B. Winton, 1958. The analysis of foods. John Wiley and Sons. Inc. London. 857.

Zarroug, Y., A. Abdelkarim, S.T. Dorra, G. Hamdaoui, M.E.L. Felah, and M. Hassouna, 2016. Biochemical characterization of Tunisian *Cichorium Intybus* L. roots and optimization of ultrasonic inulin extraction. Mediterranean Journal of Chemistry, 6(1):674–685. https://doi.org/10.13171/ mjc61/01611042220-zarroug.

Zhao, H., W. Fan, J. Dong, J. Lu, J. Chen, L. Shan, Y. Lin, and W. Kong, 2008. Evaluation of antioxidant activities and total phenolic contents of typical malting barleys varieties. Food Chemistry, 107(2): 296–304.

Zhao, Z., and M.H. Moghadasian, 2008. Chemistry, natural sources, dietary intake and pharmacokinetic properties of ferulic acid: A review. Food Chemistry ,109(4):691–702.