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Preparation and Evaluation of an Instant Drink for Athletes Based On Protein Isolates from Legumes and Cereals

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THIS study aims to prepare and evaluate an instant drink for athletes based on protein isolates from cereals and legumes. Three formulations (Formula A, B, and C) were developed with different ratios of legume and cereal protein isolates: 50% legumes and 50% cereals (Formula A), 60% legumes and 40% cereals (Formula B), and 70% legumes and 30% cereals (Formula C). All formulations contained the same proportions of date powder, cinnamon, Arabic gum, salt, and vanillin. The physicochemical properties, minerals content, color measurement, amino acid composition, and sensory properties of the final formulations were assessed. Formula A had the highest levels of protein, certain essential and non-essential amino acids, sodium, potassium, and energy value. In contrast, Formula C had the highest ash and carbohydrate contents, along with elevated levels of minerals like iron, calcium, zinc, and magnesium. Sensory evaluations of the instant drinks prepared at 5, 10, and 15% of Formulas A, B, and C indicated that the 5% of Formulas A and B achieved the highest scores in terms of odor, color, overall acceptability, and taste. This study recommends using Formula A as a good source of protein, energy, and amino acid content, and Formula C for its high carbohydrate, and ash contents, in the preparation of an instant functional drink aimed at enhancing athletic performance.

Keywords: Instant drink, protein isolates, amino acid composition, sensory evaluation.

Introduction

Recently, the production and consumption of functional foods have significantly increased, driven by health-conscious motivations. Within the realm of functional foods, the functional beverage sector is experiencing rapid growth, functional beverages containing health-enhancing components like polyphenols and amino acids, prized for their anti-aging properties, anti-inflammatory, and antioxidant (Nazir et al., 2019). This trend is largely due to beverages being an ideal medium for different bioactive and nutritional compounds, including dietary fiber, proteins, vitamins, minerals, and antioxidants. Functional beverages are available in numerous types tailored to specific health needs, including probiotic drinks, high-protein drinks, meal replacement beverages, energy drinks, and antioxidant-rich vegetable and fruit drinks. These drinks can also be categorized by their composition, such as dairy-based, non-dairy-based, vegetable-based, fermented fruit, herbal, cereal and legume-based beverages. Additionally, sports beverages fall under the category of functional beverages, often enriched with micronutrients and high protein content to address the health and recovery needs of athletes (Orrù et al., 2018).

Functional sports drinks (FSDs) offer benefits

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in hydration, enhancing athletic performance, and addressing specific medical conditions. Their formulations can be customized to improve mental clarity, increase energy levels, and alleviate joint and bone pain (Stachenfeld, 2014; Hoffman et al., 2017). According to Evans et al. (2017), the primary purpose of these drinks in a sports context is assist athletes in rehydrating and replenishing carbohydrates, minerals, and other nutrients lost during physical activity. It is known that the goal of using nutritional support is to maximize athletes' sports performance, prevent potential injuries, and speed up recovery after exercise. However, athletes' protection and performance enhancement before, during, and after exercise depend on maintaining an ideal water balance and consuming macro- and micronutrients concurrently (Bayram and Ozturkcan, 2020). So, the essential electrolytes lost through perspiration during training and competition, such as potassium, sodium, chloride, phosphate, calcium, and magnesium, are used in preparing sports drinks. Additionally, Vitamins B are important for energy production and boosting metabolism, while amino acids help reduce fatigue and improve muscle function, and complex carbohydrates offer sustained energy (Evans et al., 2017; Orrù et al., 2018).

In contemporary nutritional strategies, dietary protein intake is essential, particularly for optimizing recovery after exercise. Typical protein sources in sports supplements include whey (a by-product of cheese), casein from milk, ovalbumin from egg whites, and proteins from legumes and cereals such as rice. These proteins are crucial for the swift and efficient development of muscle tissue. Consuming protein-rich supplements before and/or after workouts has been demonstrated to significantly enhance muscle protein synthesis (Moore et al., 2022; Lopez-Martinez et al., 2022; Hodson et al., 2022). The production of alternative sports drinks also generates valuable by-products such as rice paste, which has lower carbohydrate and higher protein content compared to traditional rice products. Rice protein serves as an excellent plant-based alternative to conventional animal-based proteins such as dairy or meat (Lee et al., 2022; Wang et al., 2023). Nutritional protein drinks offer a convenient and effective way to supplement essential proteins. These beverages benefit athletes aiming for muscle growth, fitness enthusiasts focused on post-workout recovery, and individuals seeking a balanced diet for weight management or overall health (Arenas-Jal et al., 2019; Ahern et al., 2023).

Chickpea (*Cicer arietinum L.*) is a widely cultivated legume known for its significant nutritional content. It offers protein of excellent quality and serves as a plentiful source of essential amino acids, including leucine, arginine, and lysine, along with branched-chain amino acids. Chickpea proteins are recognized for their excellent digestibility and versatile techno-functional properties, including emulsification, gelling, and foaming, making them an ideal protein source for developing new products like meat alternatives and enhancing traditional foods (Goldstein and Reifen, 2022; Grasso et al., 2022). Lupins are notable for their high protein content, making them an economical functional food. They have an excellent amino acid profile, especially high in lysine compared to other plant proteins. Among lupin species, yellow lupin (L. luteus) generally boasts the highest protein content and the lowest fat content, making it ideal for producing protein isolates and concentrates, which are vital for food processing and have numerous applications in the food industry (Boukid and Pasqualone, 2022; Bou et al., 2022). Faba bean (*Vicia faba L.*), a prominent grain legume in Egypt, is increasingly recognized for its health and nutritional benefits. It is abundant in lysine, carbohydrates, minerals, vitamins, and various bioactive compounds, which contribute significantly to its dietary value (Rahate et al., 2021; Dhull et al., 2021). Cowpea seeds are notable for their high protein content, which includes all essential amino acids, and are low in fat. They also provide vitamins and essential minerals, making cowpea protein valuable for food uses. Research indicates that consuming cowpeas may help in preventing type-2 diabetes, cardiovascular disease, and cancer, due to the presence of bioactive peptides and polyphenols in the protein (Awika and Duodu, 2017; Hamadou et al., 2022). Barley is a globally significant crop, with approximately 11.5 - 14.2% crude proteins, 1.8 - 2.4% ash, 4.7 - 6.8% crude lipids, 3.7 - 7.7% β-glucans, and 80% crude carbohydrates (Zambrano et al., 2023). β-glucans, polyphenols, vitamins E and B present in barley offer notable antioxidant, anti-tumorigenic, and antibacterial benefits (Obadi et al., 2021). Rice proteins are highly valued for their excellent nutritional quality and low allergenic potential. They primarily consist of glutelin (the major protein) and prolamin (the minor protein), with notable levels of sulfur-containing amino acids such as methionine and cysteine, although they are relatively low in lysine (Amagliani et al., 2017).

A growing number of athletes are using

nutritional supplements to meet specific nutrient requirements, aiming to enhance their physical fitness and build muscle. However, these supplements are often expensive and may lead to certain health issues. Hence, this study introduces an innovative approach that uses protein isolates from cereals and legumes to prepare safe nutritional supplements for athletes. These instant drink supplements are designed to meet athletes' nutritional needs and boost their physical fitness. Therefore, this study aimed to prepare and evaluate an instant drink for athletes using protein isolates from cereals and legumes.

Materials and Methods

Materials

Chickpea, lupine, broken faba bean, cowpea, barley, rice, date, cinnamon, salt, Arabic gum, and vanillin were purchased from Alexandria markets, Egypt. In this study, Analytical-grade compounds and reagents were employed.

Methods

Preparation of protein isolates from legumes and cereals

Preparation of legumes and cereals powder:

Chickpea, lupine, broken faba bean, cowpea, barley, and rice were manually cleaned to eliminate hulls, stones, and debris. After cleaning, the samples were finely ground using a spice mill (Moulinex 180W, AR1044, France), sieved through a 500 µm mesh. The samples were defatted with n-hexane at a ratio of 1:3 (weight/volume, (w/v)). The resulting fine powder was stored in sealed plastic bags at −18°C until used.

Preparation of protein isolate:

Protein isolates were prepared from chickpea, lupine, broken faba bean, cowpea, barley, and rice powder using the isoelectric precipitation method outlined by Makri et al. (2006) with minor modifications. Defatted samples (100 g) were mixed with distilled water at a 1:10 (w/v), and the pH was adjusted to 8.0 using 1.0 M NaOH. The mixture was stirred at 500 rpm for one hour at room temperature and then centrifuged at 6600 rpm for 30 minutes at 4°C using a Sigma centrifuge 113 (VWR International, Darmstadt, Germany). The supernatants were collected, and the pH was adjusted to 4.5 using 1.0 M HCl to precipitate the proteins. The resulting precipitates were then separated by centrifugation at 6600 rpm for 30 minutes at 4°C. The protein isolates were rinsed and dispersed in 150 mL of distilled water and dried in a tray dryer at 45°C for 12 hours in a thermostatic controlled hot air oven (Memmert UN750, Germany), then kept at −18°C for use.

Date powder preparation

The dates were first cleaned, then dried at 45°C in a thermostatic controlled hot air oven (Memmert UN750, Germany) until fully dehydrated. After drying, they were ground using a Moulinex 180W grinder (AR1044, France) and stored in sealed glass containers at 20-25°C until use.

Preparation of instant drink formulations

Three formulations of instant sports drinks were prepared, as detailed in Table 1. The formulations were prepared by blending protein isolates derived from legumes, specifically chickpea, lupine, broken faba bean, and cowpea in equal proportions (1:1:1:1(w/w)), and cereal protein isolates from barley and rice in a 1:1 ratio (w/w). These protein blends were combined with date powder, cinnamon, Arabic gum, salt, and vanillin. Formula A consisted of 50% legume protein isolate and 50% cereal protein isolate. Formula B contained 60% legume and 40% cereal protein isolates, while Formula C included 70% legume and 30% cereal protein isolates. The prepared instant drink powders were bottled and stored under refrigerated conditions until evaluation.

TABLE 1. Formulation of instant drink formulations

Ingredients (g/100 g)	**Formula A** (50% legumes and 50% cereals protein isolates)	**Formula B** (60% legumes and 40% cereals protein isolates)	**Formula C** (70% legumes and 30% cereals protein isolates)
Legumes protein Isolates	40.00	48.00	56.00
Cereals protein Isolate	40.00	32.00	24.00
Dates powder	18.40	18.40	18.40
Cinnamon	1.00	1.00	1.00
Arabic Gum	0.40	0.40	0.40
Salt	0.10	0.10	0.10
Vanillin	0.10	0.10	0.10

Analytical methods

Proximate chemical composition

The approximate chemical composition (moisture, protein, fat, and ash) was analyzed according to AOAC (2023) standard method. The carbohydrate content was calculated by difference. Total energy (kcal) was calculated for the final formulations using the following equation:

$$Total\ Energy\ (kcal) = 4[\text{protein (g)} + carbohydrates\ (g)] + [9 * fat(g)]$$

Minerals content determination

Minerals content including K, Ca, Na, Mg, Fe, and Zn in formulations was determined using an ICP-OES Agilent 5100 VDV (Santa Clara, USA), following the AOAC procedure (AOAC, 2023).

Amino acid constitution

Amino acid constitution was assessed using a High-Performance Amino Acid Analyzer following the AOAC method (AOAC, 2023). The Amino Acid Score (AAS) was calculated using the following formula:

$$AAS = \text{mg of amino acid in the protein per g / mg of amino acid in the requirement pattern}$$

The obtained scores were then compared to the FAO (2013) reference values for athletes and not for specific ages.

Physicochemical properties

Bulk density

A measured quantity of instant sports drink powder was poured into a 10 mL measuring cylinder, and its volume was recorded to calculate the bulk density (weight per volume) using the method described by Jangam and Thorat (2010).

$$Bulk\ density\ (g/cm^3) = \frac{Mass\ of\ powder}{Initial\ volume\ of\ powder}$$

Water absorption capacity (WAC)

The water absorption capacity (WAC) of the instant sports drink formulation was evaluated using the methodology outlined by Theresa et al. (2020). The WAC (gram/gram (g/g)) was determined using the formula suggested by the authors.

$$WAC(g/g) = \frac{(Initial - Final\ solution\ volume) * Water\ density}{Original\ sample\ weight\ (g)} * 100$$

Swelling capacity

The swelling capacity of instant sports drink samples was evaluated at room temperature (approximately 25 ± 2°C) using the methodology described by Theresa et al. (2020) using the following formula:

$$Swelling\ Capacity\ (\%) = \frac{Volume\ occupied\ by\ sample\ before\ swelling}{Volume\ occupied\ by\ sample\ after\ swelling} * 100$$

pH value

The pH values were measured using a digital Mettler Toledo Mp 230 pH meter (Jenway, UK), following the procedure described by Goulas and Kontominas (2007).

Viscosity determination

The viscosity of the instant drink formulations was measured three times at 10°C ± 1°C using an oscillatory viscometer (VR 3000M YR Viscometers, Spain) with spindle 2 at a speed of 60 rpm, following the procedure described by Suwonsichon and Peleg (1999).

Color measurement

The lightness (L*), redness (a*), and yellowness (b*) of instant drink formulations were evaluated using a Hunter Lab Scan Visible Colorimeter (USA), following the technique outlined by Santipanichwing and Suphantharika (2007). Five measurements were recorded for each color index (L*, a*, b*).

Sensory evaluation

Twenty members of the Food Technology Research Institute, Alexandria, Egypt, evaluated the three instant drink formulations for color, texture, odor, taste, and overall acceptability, using a 9-point hedonic scale, according to the method of Banach et al. (2014) where one represents strong dislike and nine represents strong liking.

Statistical analysis

The SAS statistical analysis software program (2004) was employed to analyze the data in this study using the general linear model (GLM) procedure. The means were compared using Duncan's test at a significance level of $P \leq 0.05$, and statistical analysis was conducted via one-way ANOVA (SAS, 2004).

Results and Discussion

Proximate chemical composition of legumes, cereal flour, and their protein isolate

The approximate chemical composition of chickpea, lupine, broken faba bean, cowpea, barley, and rice flours along with their respective protein isolates, is presented in Table 2. The findings reveal that lupine flour has the highest moisture content (9.54%), while chickpea flour has the lowest (5.71%). Lupine flour had the highest protein content (42.39%), followed by broken faba bean flour (27.17%), while rice flour was the lowest (8.13%). In terms of fat and ash contents, lupine flour was the highest, while rice flour had the lowest values. Conversely, rice flour had the highest carbohydrate content (90.83%), followed by barley flour (83.25%). Lupine flour contained the lowest carbohydrate content (44.3%). These results are generally consistent with those reported by Ibrahim (2022), who found that chickpea had higher levels of protein (23.5%), fat (5.5%), and ash (3.41%) compared to rice. Conversely, rice was higher in moisture (8.26%) and carbohydrates (81.69%). Similarly, Ali et al. (2019) noted lupine flour had significantly higher levels of moisture, crude protein, and fat (10.11%, 43.17%, and 9.90%, respectively). Studies indicate that faba beans contains 25% to 40% protein, and 47% to 68% carbohydrates (Valente et al., 2019). The nutrient composition, anti-nutritional components, and phytochemical content of faba beans can vary depending on the variety and growing conditions. According to the USDA (2020), cereals such as barley and rice contain protein (9.9% and 7.5%, respectively), and carbohydrates (77.7% and 76.3%, respectively).

The results also show that cowpea protein isolate (CPI) had the highest moisture content (5.69%), while lupine protein isolate (LPI) had the lowest (4.33%). Rice protein isolate (RPI) had the highest protein content at 87.82%, followed by barley protein isolate (BPI) at 85.62%, while broken faba bean protein isolate (BFBPI) had the lowest protein content (79.97 %). BPI had the highest crude ether extract value, followed by the RPI, and the chickpea protein isolate (CPPI) had the lowest value. The BFBPI and CPPI exhibited the highest ash content. The lupine protein isolate (LPI) had the lowest ash content. The carbohydrate content of cowpea protein isolate (CPI) was the highest at 18.05%, whereas RPI had the lowest at 10.50. In this study, the protein and carbohydrate contents of the LPI were higher than those reported by Tadesse (2021). Likewise, Abdel-Haleem et al.

TABLE 2. Proximate chemical composition of legumes and cereals flour and their protein isolates (on dry weight basis)

Component	Moisture content (%)	Protein content (%)	Crude ether extracts content (%)	Ash content (%)	Total carbohydrate content (%)
			Flour		
Chickpea	5.71±0.08[d]	23.3±0.2[c]	6.00±0.44[b]	3.06±0.36[b]	67.63±0.20[e]
Cowpea	8.51±0.11[b]	23.69±0.17[c]	1.20±0.06[e]	3.21±0.10[ab]	71.90±0.18[c]
Broken faba bean	8.33±0.25[b]	27.17±0.30[b]	1.65±0.08[d]	2.26±0.15[c]	68.92±0.38[d]
Lupine	9.54±0.45[a]	42.39±0.68[a]	9.90±0.20[a]	3.41±0.11[a]	44.3±0.28[f]
Barley	6.93±0.40[c]	12.31±0.31[d]	2.48±0.08[c]	1.96±0.04[d]	83.25±0.38[b]
Rice	8.05±0.19[b]	8.13±0.38[e]	0.62±0.01[f]	0.41±0.03[e]	90.83±0.40[a]
			Protein isolates		
Chickpea	5.11±0.08[a]	80.15±0.75[c]	0.05±0.002[e]	2.11±0.04[b]	17.69±0.89[a]
Cowpea	5.69±0.09[a]	80.47±0.13[c]	0.10±0.001[d]	1.38±0.02[d]	18.05±0.19[a]
Broken faba bean	4.64±0.06[c]	79.97±0.36[c]	0.12±0.009[c]	2.21±0.05[a]	17.70±0.32[a]
Lupine	4.33± 0.09[d]	81.05±0.25[c]	0.10±0.002[d]	1.14±0.03[f]	17.72±0.32[a]
Barley	5.61±0.16[a]	85.62±0.45[b]	0.16±0.008[a]	1.23±0.04[e]	12.99±0.41[b]
Rice	5.16±0.03[b]	87.82±1.00[a]	0.14±0.009[b]	1.53±0.03[c]	10.51±0.36[c]

Values are the means ±SD of three independent replicates. Means in the same column with different letters are significantly different ($p<0.05$).

(2022) found that CPI and BFBPI contain 5.76% and 5.71% moisture, 83.38% and 88.45% protein, 0.79% and 0.57% fat, and 1.98% and 1.94% ash, respectively. Ramani et al. (2021) stated that CPPI has 8.65% moisture, 94.83% protein, 0.08% fat, 2.96% ash, and 2.13% carbohydrates. Additionally, Silventoinen & Sozer (2020) noted that the protein content in BPI rose significantly from 24.0% to 85.8%.

Proximate chemical composition of instant drink formulations

Table 3 provides an approximate chemical composition of the instant drink powder. The findings revealed that the moisture content varied between 5.04% to 5.22%. Notably, the highest moisture content (P<0.05) was found for formula A, whereas the lowest moisture content (P<0.05) was noted in formula C. Thonabut et al. (2020) found that the moisture content of an instant drink containing brown rice and beetroot powder was 6.39%. The moisture content in formulas (A, B, and C) was lower than the value of 11.38% reported by Lee et al. (2018). Consequently, the product's low moisture content allows for long-term storage. Research has confirmed the beneficial effects of protein supplementation in reducing inflammatory markers, oxidative stress, muscle damage, and improving performance (Poulios et al., 2019; Forbes et al., 2020). Athletes require a higher daily protein intake due to their accelerated muscle protein turnover and peak muscular adaptations compared to sedentary individuals. While 0.8 g/kg of protein is sufficient for sedentary individuals, the International Society of Sports Nutrition (ISSN) recommends that athletes consume 1.4-2.0 g/kg/day to build and sustain muscle mass. Those engaged in resistance training are advised to intake even higher amounts, ranging from 2.3 to 3.1 g/kg/day, to preserve lean body mass (Jäger et al., 2017).

The findings in Table 3 cleared that protein content in the instant drink samples ranged from 65.70% to 67.30%. Protein content was lowest in formula C and highest in formula A. This variation is likely due to the high protein content of ingredients like legumes and cereal protein isolates .These values surpass those reported by Swaminathan and Guha (2018), who found the protein content of a protein-rich instant rice beverage to be 20.05%. Similarly, Thakur et al. (2022) found that the high protein content (16%) of their product was due to components like Bengal gram and pea protein isolate.

The crude ether extract content in the instant drink formulas ranged from 0.041% to 0.042%. Formula C had the lowest crude ether extract content compared to formulas A and B. This value is lower than that reported by Singh et al. (2024) who noted that the fat content of a cereal-based instant beverage was 4.73%, which exceeded the fat level of a healthy drink mix available on the market, which is 1 g/100 g. Ash content is a significant indicator of mineral content in food products. In the instant drink formulas, ash content ranged from 0.516% to 0.643%, with formula C exhibiting the greatest value when compared to formulas A and B. This value is lower than that found by Swaminathan and Guha (2018), who found that a protein-rich instant rice drink had an ash concentration of 2.87%.Similarly, Singh et al. (2024) observed an ash content of 1.08% in a cereal-based instant beverage.

As shown in Table 3, the total carbohydrate content in instant drink samples varied significantly. Formula C had the highest carbohydrate content at 33.60%, whereas formula A had the lowest at 32.10%. These values are lower than mentioned by Swaminathan and Guha (2018), who found that a protein-rich instant rice beverage contained 72% total carbohydrates. Similarly, Singh et al. (2024) observed 72% carbohydrate content in a cereal-based instant beverage. A diet high in carbohydrates can significantly boost performance during endurance and intense training by increasing the availability of exogenous carbohydrates and promoting glycogen storage in muscles and the liver. Exercise gradually depletes endogenous carbohydrates based on its intensity and duration. Post-exercise, rapid carbohydrate intake helps to quickly replenish these stores and supports training adaptation. Both anaerobic and aerobic processes can digest carbohydrates, making them a crucial element of athletic effectiveness. Glycogen in the muscles and glucose in the circulation are two sources of energy that are necessary for active muscles. Consuming the appropriate amount of carbohydrates not only helps with recovery but also restores glycogen stores for use in subsequent workouts. The amount of carbohydrates that should be consumed is dependent on the volume and intensity of the workout, and it is recommended that the meal plan contain foods that have a glycemic index that ranges from low to moderate, such as complex carbs (König et al., 2020; Henselmans et al., 2022). To estimate carbohydrate needs for athletes, it is recommended to consume 3–12 grams of carbohydrates per kilogram of body weight daily, with the exact amount depending on physical activity intensity and duration. Individual differences and digestive comfort should also be considered (Reinhard and Galloway, 2022).

In terms of energy values, formula C had the lowest energy content at 397.66 kcal/100 g, while formula A exhibited the highest value at 397.97 kcal/100 g. The reported energy values are close to Swaminathan and Guha (2018) 379.45 kcal/100 g. Similarly, Keawyok et al. (2023) reported that a high-protein drink for athletes contained 371 kcal. These calorie values represent the energy derived from macronutrients such as carbohydrates, proteins, and fats. Research shows that both exercise training and the proportion and timing of dietary intake significantly impact an athlete's energy expenditure and performance (Kerksick et al., 2017). Maintaining optimal performance in sports relies heavily on precise nutritional strategies and adequate energy intake, which are crucial for effective recovery, preventing fatigue, and minimizing the risk of injuries and illnesses. Athletes' daily energy requirements range between 40-70 kcals/kg/day, equating to 2000-7000 kcals/day for a 50-100 kg athlete (Papadopoulou, 2020).

Minerals content of instant drink formulations

Minerals and vitamins are essential for a variety of human functions, including optimizing athletic performance. Athletes have a high turnover of these nutrients and require sufficient energy intake to replenish their stores. Some athletes might need to consider vitamin and/or mineral supplements to meet their daily requirements (Peeling et al., 2023). Table 3 presents the mineral content of the instant drink formulations. Sodium (Na) levels ranged from 25.55 to 45.01 mg/100 g, and potassium (K) levels ranged from 95.31 to 118.84 mg/100 g. Formula A had the highest sodium and potassium concentrations ($P < 0.05$), while formula C had the lowest. In contrast, formula C had the highest levels of calcium, magnesium, iron, and zinc, with values of 388.5, 3.41, 9.01, and 3.30 mg/100 g, respectively. These results are lower than those reported by Swaminathan and Guha (2018), who found their protein-rich instant rice beverage contained 680 mg of calcium, 9.3 mg of iron, 13.5 mg of magnesium, 3.2 mg of zinc, 1.02 mg of manganese, and 0.56 mg of copper per 100 g. Additionally, Keawyok et al. (2023) reported high-protein drinks for athletes contained 128 mg of sodium and 306 mg of calcium per 100 g, although the iron content was higher in the present study. Iron (Fe) is particularly crucial for physical performance because it is vital for producing red blood cells, which transport oxygen to muscles. Adequate iron intake is necessary for optimal performance, as iron deficiency can lead to fatigue and lethargy. Iron is also important for immune response, growth, and hormone production. Dietary iron intake recommendations from the World Health Organization (WHO) and various national health agencies suggest that females need 18 mg and males need 8 mg per day (Alaunyte et al., 2015; Pradita et al., 2020). Sodium is another essential electrolyte, especially for athletes who lose significant amounts of sweat. Many endurance athletes require more sodium (2.3 g/day) and chloride (3.6 g/day) than the general upper limit. For these athletes, sports drinks containing sodium (0.5–0.7 g/L) and potassium (0.8–2.0 g/L), are recommended, particularly during endurance events lasting more than two hours (Palmer and Spriet, 2008). Potassium (K) is essential for athletes' health and performance, playing a critical role in muscle contractions, fluid balance, blood pressure regulation, and heart rate control. It is also important for nerve function and maintaining electrolyte balance, which is particularly beneficial during prolonged practices or games. Adequate potassium levels help prevent injuries, sustain energy levels, minimize lactic acid buildup in muscles (thereby reducing fatigue), and support a healthy metabolism (Sone et al., 2022). Furthermore, magnesium (Mg) supports muscle relaxation and tenseness, leading to improved muscular coordination and physical performance. It also aids in reducing lactic acid buildup in muscles, which can alleviate exercise-induced pain and accelerate recovery (Hunt et al., 2021).

Athletes may also lose calcium through sweat, necessitating replenishment through calcium-rich foods or commercial supplements. It is crucial for athletes to consume a diet that provides sufficient energy, protein, fat, vitamins, minerals, and fluids to meet the physical demands and compensate for the physiological losses from training (Chauhan, 2022). Moreover, physical activity raises the demand for certain vitamins and minerals, many of which are readily absorbed from animal products. Zinc (Zn), for instance, is crucial for muscle growth, repair, and recovery. Zinc supplementation can improve athletic performance by decreasing blood viscosity and improving oxygen transport, resulting in increased aerobic endurance. It also contributes to greater strength and endurance. Studies reveal that "sports anemia," a zinc deficiency that can negatively impact performance, frequently affects both male and female athletes. Meat is considered one of

TABLE 3. Proximate composition and minerals content of instant drink formulations (on dry weight basis)

Component	Formula A	Formula B	Formula C
Moisture content (%)	5.22±0.03[a]	5.12±0.04[b]	5.04±0.03[c]
Protein content (%)	67.30±0.57[a]	66.00±0.79[b]	65.70±0.60[b]
Crude ether extract content (%)	0.042±0.006[a]	0.042±0.002[a]	0.041±0.001[a]
Ash content (%)	0.516±0.001[c]	0.558±0.022[b]	0.643±0.026[a]
Total carbohydrate content (%)	32.10±0.58[b]	33.40±0.81[ab]	33.60±0.58[a]
Total energy (kcal/ 100g)	397.97±0.084[a]	397.84±0.145[ab]	397.66±0.098[b]
Minerals content (mg/100g)			
Na	45.01±0.49[a]	30.15±0.25[b]	25.55±0.33[c]
K	118.84±0.28[a]	116.55±0.47[b]	95.31±0.35[c]
Ca	317.03±0.31[c]	346.2±0.27[b]	388.5±0.42[a]
Mg	2.22±0.03[c]	2.84±0.04[b]	3.41±0.09[a]
Fe	7.63±0.08[c]	8.45±0.06[b]	9.01±0.09[a]
Zn	3.08±0.01[c]	3.20±0.02[b]	3.30±0.02[a]

Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates), Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates), Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates). Values are the means ± SD from three independent replicates. Means within the same column marked with different letters are significantly different (p<0.05).

the best sources of zinc (Hernández-Camacho et al., 2020). According to the previous studies, the recommended daily mineral requirements for athletes are 1000 mg of calcium, 2000 mg of potassium, 8 mg of iron, 420 mg of magnesium, 500 mg of sodium, 1 mg of copper, 11 mg, and 8 mg of zinc for males and females (Kerksick et al., 2018; Chauhan, 2022).

Amino acid composition of instant drink formulations

The amino acid composition and bioavailability of different protein sources influence the protein quality and efficiency of a meal in boosting muscle protein synthesis (Meyer et al., 2020). Table 4 presents the amino acid constituents of the instant sports drink formulations. formula A showed a slight increase in most essential amino acids compared to formulas B and C, including leucine, phenylalanine, methionine, and histidine (70.30, 47.53, 8.91, and 23.76 mg/g protein, respectively). Conversely, Formula C contained higher levels of threonine and isoleucine. Regarding non-essential amino acids, formula A demonstrated the highest level of aspartic acid, glutamic acid, glycine, alanine, proline, and cystine, with values of 96.04, 193.07, 41.59, 48.52, 60.40 and 11.88 mg/ g protein, respectively. Conversely, formula C had the highest amounts of tyrosine and arginine. Additionally, Formula B had the highest total aromatic amino acids (TAAA), and total branched-chain amino acids (BCAAs) compared to formulas A and C. The amino acid score (AAS), which measures the ratio of the amount of an individual amino acid in a food product to the recommended amount for that amino acid (WHO, 2007), showed that formula C achieved the highest AAS for threonine, valine, and isoleucine, while Formula A had higher AAS values for leucine, phenylalanine, methionine, and histidine.

Recent research indicates that plant-based protein sources can stimulate muscle protein synthesis to the same extent as animal proteins, as long as they are ingested in quantities that match the amino acid composition of animal proteins and supplemented with foods that are high in the amino acids they lack. Plant-based proteins can effectively stimulate muscle protein synthesis and minimize muscle damage to the same extent as proteins derived from animals. Nevertheless, athletes may require increased quantities of plant-based protein sources to fulfill their protein requirements (Meyer et al., 2020).

Branched-chain amino acids (BCAAs) are crucial for enhancing muscle protein synthesis and promoting muscular growth. BCAAs (leucine, isoleucine, and valine) are mostly absorbed in the skeletal muscles rather than the liver, unlike other amino acids. BCAAs play important roles in neurological function, blood glucose and insulin regulation, and protein metabolism in skeletal muscles. Furthermore, BCAAs have the ability to augment muscle growth and improve exercise performance, as stated by Gorissen and Phillips (2019). The body cannot produce the essential branched-chain amino acids (BCAAs) leucine, isoleucine, and valine, so we must obtain them from food (Neinast et al., 2019). Unlike other amino acids, skeletal muscle directly oxidizes BCAAs without the liver's involvement. Leucine is particularly noted for enhancing performance, aiding recovery, and improving body composition by regulating muscle protein synthesis (MPS) (Australian Institute of Sports, 2021). BCAAs supplementation can also reduce muscle soreness, an indicator of muscle damage (Doma et al., 2021). Vegetarian athletes can ensure sufficient essential amino acid intake and maximize anabolic responses by pairing foods that are high in methionine with foods that are high in lysine, using isolated protein blends, or complementing inadequate amino acids (Pinckaers et al., 2021).

Physicochemical properties of instant drink formulations

Bulk density

Bulk density measures the weight of a material; a lower bulk density is nutritionally advantageous because it enhances product digestibility. A lower bulk density allows more flour particles to bind together, thereby boosting the diet's energy content. The low-density readings of the food samples indicate that preparing them with less water can still achieve the optimal level of energy and nutrients. Bulk density is influenced by multiple factors, comprising particle shape and size, surface characteristics, and the density of the solid material (Dilrukshi and Senarath, 2021). Findings indicate that formula C had the highest bulk density (0.899 g/cm³), while formula B showed the lowest (0.726 g/cm³), as shown in Table 5. Bulk density is a critical parameter, as is influence the powder flowability and instant solubility characteristics. Research indicates that cereal-based flour bulk density typically ranges from 0.76 to 0.84 g/cm³. Higher bulk and tapped densities suggest that particles are more closely packed, occupying the gaps between them and resulting in a greater packing density, which requires reduced volume of packaging. The inter-particulate interactions that might hinder powder flow are impacted by both bulk and tapped densities. Increasing the bulk density of the powder reduces the amount of air trapped inside it, which in turn decreases the likelihood of oxidation and improves the powder's stability during storage. Therefore, a high bulk density in flour is advantageous for food preparations since it reduces the expenses associated with shipping and packaging (Barba et al., 2020).

Water absorption capacity (WAC)

The water absorption capacity (WAC) measures the amount of water that food or powder absorbs to achieve the desired texture and quality in the final product. It shows the optimal amount of water needed for dough before it becomes too sticky. Both insufficient and excessive WAC can have a detrimental impact on the quality of food. Water absorption is typically expressed relative to the weight of the food or flour. For instance, 60% WAC indicates the use of 60 lbs of water to rehydrate 100 lbs of flour (Godswill, 2019). According to the data in Table 5, formula B showed the highest water absorption capacity (1.853 g/g), followed by formula C (1.548 g/g), while formula A had the lowest (1.133 g/g). Foods contain hydrophilic components, like proteins, that attract water molecules. Variations in WAC among different foods or flours can be connected to variations in protein quantities, characteristics, and their interaction with water. Majiding et al. (2023) found that the water absorption capacity (WAC) of an instant powder drink produced from yellow sweet potatoes and red beans were measured to be 4.98 mL.

Swelling capacity

As shown in Table 5, the instant drink samples exhibited a swelling capacity (SC) ranging from 1.341 ml/g to 2.201 ml/g, with formula C exhibiting the highest value and formula A the lowest. SC measures the milliliters of water absorbed by a single gram of food material during its expansion under specific conditions. The addition of water or an appropriate swelling agent to the food material, regardless of whether it is whole, crushed, or cut, determines this. Starch's water absorption and expansion abilities, as measured by SC, reveal the strength of the associative forces within starch granules. Factors such as particle size, species variety, and processing methods have an impact on flours' swelling capacity. Due to the complex structure of starch polysaccharides, water penetrates slowly, leading to greater water retention and enhanced swelling. Proteins, being hydrophilic, have various groups such as carboxyl, amino, hydroxyl, and amide, which strongly attract water molecules through hydrogen bonding (Godswill, 2019).

TABLE 4. Amino acid composition of instant drink formulations

Amino Acids	Amino Acids (mg/g protein)			Amino Acid Score (AAS)			Reference protein (mg/g)*
	Formula A	Formula B	Formula C	Formula A	Formula B	Formula C	
			Essential amino acids				
Therionine (THR)	32.67	34.01	34.45	69.37	72.21	73.15	47.1
Valine (VAL)	42.57	43.66	43.70	60.56	62.11	62.16	70.3
Isoleucine (ILE)	37.62	39.07	39.50	59.91	62.21	62.89	62.8
Leucine (LEU)	70.30	69.40	67.23	84.39	83.31	80.71	83.3
Phenylalanine (PHE)	47.53	46.42	44.54	86.88	84.86	81.42	54.7
Lysine (LYS)	47.53	48.26	47.90	62.78	63.75	63.28	75.7
Methonine (MET)	8.91	8.73	8.40	30.10	29.50	28.39	29.6
Hisitidine (HIS)	23.76	23.44	22.69	104.68	103.26	99.95	22.7
Total essential amino acids	310.89	312.99	308.40				
			Non- essential amino acids				
Aspartic (ASP)	96.04	93.76	89.92	288.41	281.56	270.02	33.3
Seine (SER)	40.59	40.91	40.34	48.38	48.75	48.08	83.9
Glutamic (GLU)	193.07	176.95	159.66	341.11	312.63	282.09	56.6
Glycine (GLY)	41.59	41.36	40.34	124.88	124.22	121.13	33.3
Alanine (ALA)	48.52	43.20	37.82	78.89	70.25	61.49	61.5
Tyrosine (TYR)	32.67	34.93	36.13	80.28	85.82	88.78	40.7
Argnine (ARG)	72.28	75.35	76.47	96.24	100.37	101.83	75.1
Proline (PRO)	60.40	50.56	41.18	144.14	120.66	98.27	41.9
Cystine (CYS)	11.88	11.95	11.77				
Total non-essential amino acids	597.03	568.99	533.61				
Total Aromatic Amino Acids (TAAA)	80.20	81.35	80.67				
Total Sulfur-containing Amino Acid (TSAA)	8.91	8.73	8.40				
Total Branched-chain amino acids (BCAAs)	150.50	152.13	150.42				

Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates), Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates), Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates). Total Aromatic Amino Acids (TAAA)= Tyrosine + Phenylalanine, Total Sulfur-containing Amino Acids (TSAA)= Cystein + Methionine, Total Branched-chain amino acids (BCAAs)= Leucine + Isoleucine + Valine. *Reference protein: Represents egg protein composition (FAO, 2013).

TABLE 5. Physicochemical properties of instant drink formulations

Property	Bulk density (g/cm^3)	Water absorption capacity (g/g)	Swelling capacity (ml /g)	pH
Formula A	0.793±0.004^b	1.133±0.007^c	1.341±0.080^c	6.86±0.006^b
Formula B	0.726±0.012^c	1.853±0.048^a	2.040±0.048^b	7.04±0.010^a
Formula C	0.899±0.006^a	1.548±0.023^b	2.201±0.039^a	6.83±0.006^c

Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates). Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates). Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates). Values are the means ±SD of three independent replicates. Means in the same column with different letters are significantly different (*p*<0.05).

pH values

The pH values of the instant drink formulations, as indicated in Table 5, ranged between 6.83 and 7.04, with significant differences among the samples. Formula B had a significantly higher pH (P≤0.05) compared to the other formulas. This value aligns with those reported by Thonabut et al. (2020), who found that a germinated brown rice drink mixed with instant beetroot powder had a pH within the non-degradation range, typically falling between pH 3 and 7 for beetroot. Furthermore, Thakur et al. (2022) found that the pH value of a grain-based carbonated beverage was 5.56.

Determination of viscosity of prepared instant drink formulations

Figure 1 presents the viscosity percentages for instant drink formulation. It is evident that the viscosity value increases significantly (P < 0.05) with increased concentrations in all formulations. Formula A had higher viscosity values than formulas B and C at a 15% concentration. The increasing viscosity of the instant drink formulation could be due to the presence of total solids like higher carbohydrate and protein components, which tend to elevate the viscosity of a product. Hence, high protein and carbohydrate contents in this product likely influence its viscosity (Majiding et al., 2023). According to Swaminathan and Guha (2018), the protein-rich instant rice beverage exhibited a low pasting profile, with a peak viscosity of 3 BU, a hot paste viscosity of 2 BU, and a cold paste viscosity of 4 BU. The low viscosity profile is advantageous for beverage composition, as it allows for a high concentration of solids per unit volume without resulting in a thick texture in the mouth.

Color measurement of instant drink formulations

Color is an essential characteristic that has a significant impact on the sensory appeal. Table 6 displays the color properties of the instant drink formulations, specifically lightness (L*), redness (a*), and yellowness (b*). The L* values of the drink samples significantly rose (P<0.05) as the concentrations of formulation powders (A, B, and C) increased in all instant drink formulations. The lightness (L*) values for formulations A, B, and C ranged from 34.75 to 54.21, 44.51 to 49.90, and 39.04 to 45.45, respectively. Formula B exhibited a higher lightness value at 5% concentration compared to formulas A and C, while formula A was the highest at the higher concentration (15%). Similarly, yellowness values increased significantly (P < 0.05) with increased concentrations of formulations (A, B, and C) powder in drink samples. The yellowness (b*) values of formulations A, B, and C varied between 12.06 to 25.82, 16.46 to 28.45, and 20.43 to 21.22, respectively. At 10% and 15%, formula B showed higher b* values compared to formulas A. Otherwise, redness (a*) values decreased significantly (P < 0.05) with increased concentrations of formulations in the drink samples. Formulations A, B, and C had redness values (a*) ranging from 16.24 to 16.58, 13.40 to 13.65, and 12.09 to 12.83, respectively. Notably, formula C exhibited lower a* values compared with formulation samples. These findings may be attributed to the formulations' elevated protein content. The lightness value in the present study was lower than mentioned by Thakur et al. (2022), who found that the L* value of a carbonated grain beverage mix was 79.01.

Lee et al. (2018) found that instant cereal beverage powder with 10% corncob powder had significantly lower L* (8.85) and b* (5.72) values compared to instant cereal beverage powder with 10% corncob powder (ICB10), and instant cereal

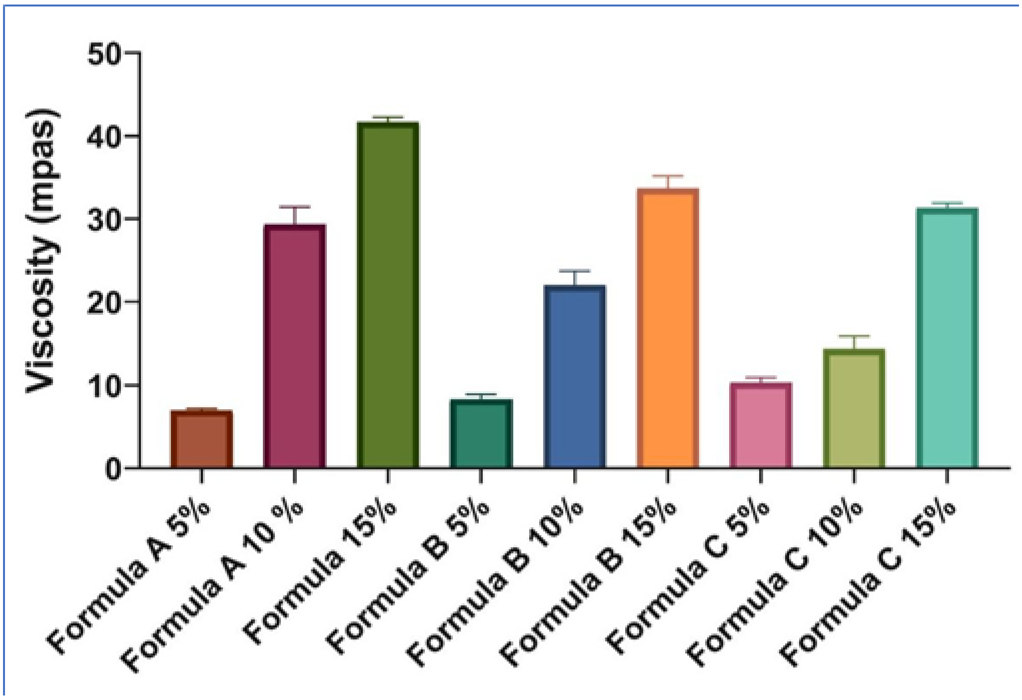

Fig 1. Viscosity of prepared drink of different formulations, Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates), Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates), Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates).

beverage powder with 20% corncob beverage (ICB20). Thonabut et al. (2020) observed that a germinated brown rice drink mixed with instant beetroot powder had color values of L* (78.10), a* (7.06), and b* (4.63), indicating a bright appearance. The high L* value was due to the low content of 7% of germinated brown rice and beetroot powder. The positive a* value indicated the red color of the beetroot, while the positive b* value reflected a yellow hue akin to that of germinated brown rice. These color values are critical for consumer acceptance, ensuring the product's color closely matches the ingredients used. Additionally, Abdel-Haleem et al. (2022) discovered that cowpea protein isolate was considerably (P≤0.05) darker and redder than those from faba bean and white bean brokens. The protein isolates from faba beans had the most yellow hue and the least red hue (P≤0.05), but it exhibited a similar lightness intensity (P≤0.05) to the protein isolate from white beans that had been fractured. While lighter protein isolates can be directly incorporated into a variety of food products, darker ones may necessitate depigmentation prior to their use in food products.

Sensory evaluation of prepared drink formulations

Sensory evaluation provides valuable insights into consumers potential purchasing and consumption decisions. Therefore, these assessments must accurately gauge product quality, including aspects like color, taste, texture, odor, and overall acceptability of the instant drink samples, as shown in Table 7. Notably, sensory evaluation scores for all instant drink formulations significantly decreased (P < 0.05) as the concentration of the drink mixture increased. Although all samples were highly accepted, the panelists favored the 5% concentrate in formulas A and B for color, odor, taste, and overall acceptability. Each aspect color, texture, taste, odor, and overall acceptability scored more than 7, indicating good acceptance. The results indicated that formula C received lower scores for color, texture, taste, and overall acceptability compared to the other formulas A and B, particularly at higher concentrations (10% and 15%). However, it was ranked moderately according to the 9-point Hedonic scale. This could be attributed to the formula C composition of 70% legumes and 30% cereal, which influenced the sensory evaluation scores. Meanwhile, significant differences were noted in all sensory evaluations between the three formulas. Ramaswamy and Fathima (2017) found no significant differences in appearance, flavor, and color among the four sports drink samples. However, significant differences were noted in taste, overall acceptability, and texture.

Furthermore, the formulated sports drinks were effective in meeting the nutritional needs of athletes. These findings are in agreement with the findings obtained by Singh et al. (2024), who found that sensory evaluation of a cereal-based instant beverage formulation showed appearance scores ranging from 6.6 to 7.9. The addition of pulses, fruits, and vegetables significantly ($p<0.05$) enhanced the appearance and color of the product, while cereals, pulses, and fruits significantly ($p<0.05$) enhanced texture. Pulses and vegetables significantly ($p<0.05$) enhanced consistency, with texture scores ranging from 6.7 to 8.2.

Nutrition facts of the instant drink formulations

Table 8 displays the nutrition facts of the instant drink formulations studied. For a daily diet of 4500 calories, it was observed that 30 grams of formulas (A, B, and C) provide 2.65% of the daily calorie requirement. Additionally, the results indicate that 30 grams of these formulas cover 0.009% of daily fat needs, 19.89%, 19.50%, and 19.43% of daily protein requirements, and 1.83%, 1.91%, and 1.92% of daily carbohydrate needs, respectively. For amino acids, 30 grams of formulas A, B, and C provide 51.79 mg, 50.15 mg, and 48.39 mg of leucine, respectively; 54.21 mg, 55.29 mg, and 55.71 mg, respectively, of daily isoleucine requirements; and 47.31, 47.47, and 47.31 mg, respectively, of valine. Therefore, the instant drink formulations can serve as valuable nutritional supplements. The therapeutic and nutritive value of these prepared sports drinks can be emphasized and recommended as rejuvenating beverages for athletes looking to improve their physical health and athletic performance.

Conclusion

Three instant drink recipes, labeled A, B, and C, were created in the present investigation. These formulas were made using identical amounts of date powder, cinnamon, Arabic gum, salt, and vanilla, but with different ratios of legume and cereal protein isolates: 50% legumes and 50% cereals in formula A, 60% legumes and 40% cereals in formula B, and 70% legumes and 30% cereals in formula C. formula A exhibited the highest protein content, some essential and non-essential amino acids, sodium, potassium, and energy levels. Conversely, formula C had the highest carbohydrate and ash contents, along with a content of minerals including calcium, magnesium, iron, and zinc. Panelists preferred the 5% concentration in formulas A and B for color, odor, taste, and overall acceptability, with each attribute scoring above 7, indicating good acceptance. Hence, the nutritional value of these developed sports drinks can be highlighted and recommended as revitalizing beverages for athletes aiming to enhance their physical health and athletic performance.

TABLE 6. Color measurement of the instant drink formulations

Formulas	Concentrates	Lightness (L*)	Redness (a*)	Yellowness (b*)
Formula A	5%	$34.75±0.4^{Cc}$	$16.58±0.48^{Aa}$	$12.06±0.92^{Cc}$
	10%	$44.28±0.45^{ABb}$	$16.47±0.35^{Aa}$	$23.48±0.47^{Bb}$
	15%	$54.21±0.50^{Aa}$	$16.24±0.61^{Aa}$	$25.82±0.41^{Ba}$
Formula B	5%	$44.51±0.27^{Ab}$	$13.65±0.33^{Ba}$	$16.46±0.37^{Bc}$
	10%	$44.60±0.51^{Ab}$	$13.61±0.77^{Ba}$	$24.9±0.57^{Ab}$
	15%	$49.90±0.61^{Ba}$	$13.4±0.35^{Ba}$	$28.45±0.82^{Aa}$
Formula C	5%	$39.04±0.77^{Bc}$	$12.83±0.78^{Ba}$	$20.43±0.50^{Aa}$
	10%	$43.23±0.67^{Bb}$	$12.38±0.83^{Ba}$	$20.7±0.25^{Ca}$
	15%	$45.45±0.26^{Ca}$	$12.09±0.32^{Ca}$	$21.22±0.51^{Ca}$

Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates). Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates). Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates). Values are means ±SD of three independent replicates. Means with different superscripts (A, B, C) in each column at the same time for the various treatments are significantly different ($P<0.05$) while means with different superscripts (a, b, c) in each row at various concentration for the same treatment are significantly different ($P<0.05$).

TABLE7. Sensory evaluation of prepared drink formulations

Formulas	Concentrates	Color	Texture	Odor	Taste	Overall acceptability
Formula A	5%	8.18±0.41^{Aa}	7.82±0.41^{Aa}	8.36±0.51^{Aa}	8.27±0.47^{Aa}	8.09±0.20^{Aa}
	10%	7.36±0.51^{Ab}	6.91±0.54^{Ab}	7.46±0.69^{Ab}	7.18±0.41^{Ab}	7.55±0.52^{Ab}
	15%	7.36±0.51^{Ab}	7.18±0.41^{Ab}	8.27±0.91^{Aa}	7.32±0.46^{Ab}	7.35±0.48^{Ab}
Formula B	5%	7.82±0.41^{Aa}	7.09±0.49^{Ba}	8.27±0.61^{Aa}	7.18±0.56^{Ba}	7.64±0.51^{Ba}
	10%	6.36±0.51^{Bb}	6.18±0.41^{Bb}	7.09±0.63^{Ab}	6.91±0.30^{Aa}	7.00±0.22^{Bb}
	15%	6.45±0.52^{Bb}	6.27±0.47^{Bb}	7.09±0.58^{Bb}	6.82±0.60^{Ba}	6.64±0.51^{Bb}
Formula C	5%	6.09±0.54^{Ba}	6.46±0.52^{Ca}	7.27±0.52^{Ba}	6.64±0.51^{Ca}	6.82±0.41^{Ca}
	10%	5.72±0.47^{Cb}	5.7±0.47^{Cb}	6.36±0.51^{Bb}	5.73±0.47^{Bb}	6.00±0.45^{Cb}
	15%	5.00±0.22^{Cc}	5.00±0.22^{Cc}	6.73±0.56^{Bb}	5.36±0.45^{Cb}	5.18±0.41^{Cc}

Formula A (instant drink prepared of 50% legumes and 50% cereal protein isolates). Formula B (instant drink prepared 60% legumes and 40% cereals protein isolates). Formula C (instant drink prepared 70% legumes and 30% cereals protein isolates). Values are means ±SD of three independent replicates. Means with different superscripts (A, B, C) in each column at the same time for the various treatments are significantly different (P<0.05) while means with different superscripts (a, b, c) in each row at various concentration for the same treatment are significantly different (*P*<0.05).

TABLE 8. Nutrition facts of instant drink formulations

Nutrition Facts**	Formula A		Formula B		Formula C	
	Amount Per Serving	% Daily Value*	Amount Per Serving	% Daily Value*	Amount Per Serving	% Daily Value*
Calories (kcal)	119.39	2.65	119.35	2.65	119.30	2.65
Carbohydrate (g)	9.63	1.83	10.02	1.91	10.08	1.92
Fat (g)	0.013	0.009	0.013	0.009	0.012	0.009
Protein(g)	20.19	19.89	19.79	19.50	19.72	19.43
Leucine (mg)	1.42	51.79	1.37	50.15	1.33	48.39
Isoleucine (mg)	0.759	54.21	0.774	55.29	0.780	55.71
Valine (mg)	0.861	47.31	0.864	47.47	0.861	47.31
Na (mg)	13.50	2.70	9.05	1.81	7.67	1.53
K (mg)	35.65	1.78	34.97	1.75	28.59	1.43
Ca (mg)	95.11	9.51	103.86	10.39	116.55	11.66
Mg (mg)	0.666	0.159	0.852	0.203	1.02	0.244
Fe (mg)	2.29	28.61	2.54	31.69	2.70	33.79
Zn (mg)	0.924	11.55	0.960	12.00	0.990	12.38

* % Daily Value is calculated based on a 4500-calorie diet.

** Serving Size 30 g.

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