Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2023 Jan 26; 11(A):99-104.
https://doi.org/10.3889/oamjms.2023.11302
eISSN: 1857-9655
Category: *A - Basic Sciences*
Section: *Sports Medicine*

Product Development of Rehydration Milk Drinks for Athletes after Exercise (Organoleptic Assessment and Nutritional Content)

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Edited by: Sinisa Stojanoski
Citation: Hizni A, Samuel S, Sholichin S. Product Development of Rehydration Milk Drinks for Athletes After Exercise (Organoleptic Assessment and Nutritional Content). Open Access Maced J Med Sci. 2023 Jan 26; 11(A):99-104. https://doi.org/10.3889/oamjms.2023.11302
Keywords: Athlete; Avocado; Guava; Milk drink; Rehydration
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Received: 22-Nov-2022
Revised: 20-Dec-2022
Accepted: 16-Jan-2023

Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Lack of drinking causes dehydration. Dehydration conditions affect the muscle performance, muscle endurance, and muscle strength of athletes.

AIM: The aim of the study was to study the organoleptic assessment of rehydration milk drink for athletes after exercise.

METHODS: This was an experimental research design using completely randomized design. The beverage formulation consists of an avocado rehydration milk drink (ARMD), a guava rehydration milk drink (GRMD), and a guava and ARMD (GARMD). The organoleptic evaluation was carried out by athletes with a preference scale (hedonic) from 1 (very dislike) to 10 (very like) for color, odor, taste, texture, and overall.

RESULTS: The organoleptic assessment of all parameters showed no differences between the variants of each treatment ($p > 0.05$). The highest mean values for all organoleptic parameters for each treatment were ARMD1 (mean value 7.16), GRMD1 (mean value 8.03), and GARMD1 (mean value 6.86). The overall mean value is determined to be the best product of each treatment. Of the three treatments, GRMD1 had a better overall organoleptic mean score compared to ARMD1 and GARMD1. The nutritional content of GRMD1/100 g contains energy of 67.69 kcal, 8.04% carbohydrates, 2.65% protein, 2.77% fat, 15.45 mg of omega-3 fatty acids, 7.99 mg Vitamin C, and 13.85% sugar.

CONCLUSION: The overall organoleptic assessment of parameters showed no differences between the variants of each treatment. GRMD1 with the highest overall organoleptic score (8.03) contains energy of 67.69 kcal, 8.04% carbohydrates, 2.65% protein, 2.77% fat, 15.45 mg omega-3 fatty acids, 7.99 mg of Vitamin C, and 13.85% sugar per 100 g.

Introduction

Lack of drinking can cause dehydration. The state of dehydration greatly affects the performance of athletes. Athletes must be able to meet the needs of fluids in their bodies [1]. If the amount of fluid is reduced, it will affect the process of energy catabolism. The results of research showed that there was a relationship between fluid intake during the exercise period and hydration status [2]. Dehydration conditions affect muscle performance, muscle endurance, and muscle strength [3].

During exercise, it is estimated that there will be a weight loss of 0.1–3.0% [4]. This shows that there is an influence between hydration level and athlete's training volume [5]. The research results showed that dehydration is also marked by a change in urine color [6].

Giving fruit juice can prevent dehydration [7]. Avocado and red guava are fruits that can be used as juice. Avocados contain a source of fat and omega-3 fatty acids [8]. The role of omega 3 and omega 6 fatty acids can be useful as an anti-inflammatory [9]. Consumption of omega-3 fatty acids is known to have health effects on cognition and neuromuscular function. Intake of omega-3 fatty acids has a positive effect on skeletal muscles. Intake of omega-3 fatty acids also reduces the loss of muscle mass and prevents decreased mitochondrial respiration [10]. Likewise, red guava fruit is rich in Vitamin C and minerals [11]. Consuming omega-3 polyunsaturated fatty acids, and Vitamin C as an antioxidant is needed to support athlete recovery [12].

Other foodstuffs such as milk can provide better quality recovery nutrients for muscle protein synthesis, replenishment of glycogen, accelerate rehydration, and physical endurance [13]. Drinks containing milk are absorbed better than ordinary drinks in maintaining fluid balance [14]. Based on the problems and benefits of avocado, red guava, and milk, we tried to formulate milk and fruit as a post-workout rehydration drink.

Methods

Experimental research design with completely randomized design consisted of three treatments, each treatment consisted of four sub-treatments, and each

sub-treatment was repeated 2 times, so there were 24 treatments.

The ingredients are *full cream*, avocado, and red guava with each of four formulas for avocado milk, four formulas for red guava milk, and four formulas for a mixture of milk, avocado, and red guava. Other complementary materials are red bean flour and sucrose. Avocado and red guava are crushed using *a food processor.* All ingredients are mixed according to the formulation, then pasteurized at 65°C for 30 min.

Organoleptic testing used non-standard panelists from 30 martial arts athletes. The organoleptic assessment used a hedonic scale (liked) from 1 (very disliked) to 10 (very liked) on the parameters of color, odor, taste, texture, and overall. Analysis of the organoleptic assessment of each variant using the *Kruskal–Willis*. The nutritional content analyzed was energy, carbohydrates, protein, fat, omega-3, Vitamin C, and sugar.

Results and Discussion

Organoleptic assessment

The development of rehydration milk drink products for athletes applies a pasteurization process with techniques *Low-temperature Long-time*. Pasteurization is a heat treatment to kill some of the pathogenic microorganisms present in food. Rehydrated milk beverage products after pasteurization are stored at cold temperatures as a preservation effort to create an uncomfortable environment for the growth of microorganism [15]. The results of the development of rehydration milk drink products for athletes are shown in Table 1 and Figures 1-3.

Table 1: Average organoleptic value of rehydration milk drink

Product type	Organoleptic parameters				
	Color	Odor	Taste	Texture	Overall
Avocado rehydrated milk drink (ARMD)					
ARMD1	6.61	6.03	6.18	6.25	7.16
ARMD 2	6.63	6.43	5.84	6.21	6.84
ARMD 3	6.34	5.99	5.14	5.90	6.29
ARMD 4	6.23	6.15	5, 39	5.68	6.25
p-value	0.673	0.424	0.307	0.734	0.148
Guava rehydrated milk drink (GRMD)					
GRMD1	7.12	7.25	7.32	6.88	8.03
GRMD2	7.21	7.14	7.21	7.14	7.96
GRMD3	7.12	6.95	7.42	7.22	7.99
GRMD4	7.20	7.01	7.04	6.79	7.83
p-value	0.742	0.632	0.546	0.517	0.805
Guava avocado rehydration milk drink (GARMD)					
GARMD1	6.51	6.24	5.72	6.42	6.86
GARMD2	6.06	5.65	5.27	5.73	6.37
GARMD3	5.98	5.46	4.82	5.55	5.98
GARMD4	5.88	5.54	4.47	5.07	5.98
p-value	0.091	0.11	0.281	0.036*	0.173

Kruskal–Wallis test, *significant $p < 0.05$.

Formula avocado rehydration milk drink (ARMD) was made from full cream milk (71.9–80.6%), avocado (8.1–18.0%), red beans (9.0–10.1%), and fructose (1.1–1.2%), which were formulated by mixing the ingredients and then pasteurized at 65°C for 30 min. Table 1 shows that there is no difference in the organoleptic assessment of avocado-rehydrated milk drinks on all organoleptic parameters. The highest average score overall was in the ARMD1 product (mean value 7.16).

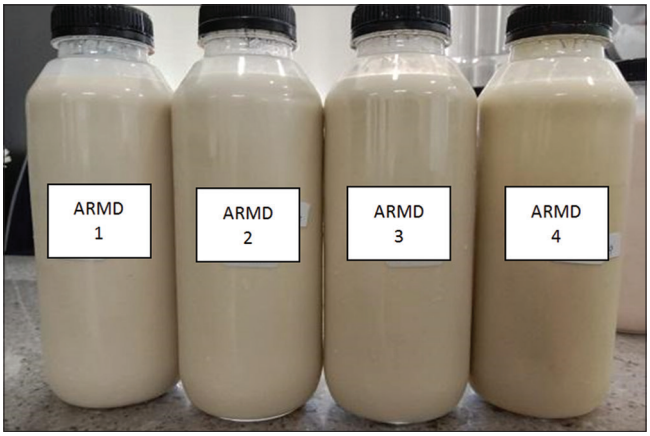

Figure 1: Avocado rehydration milk drink (Source: Researcher's Private Collecyion)

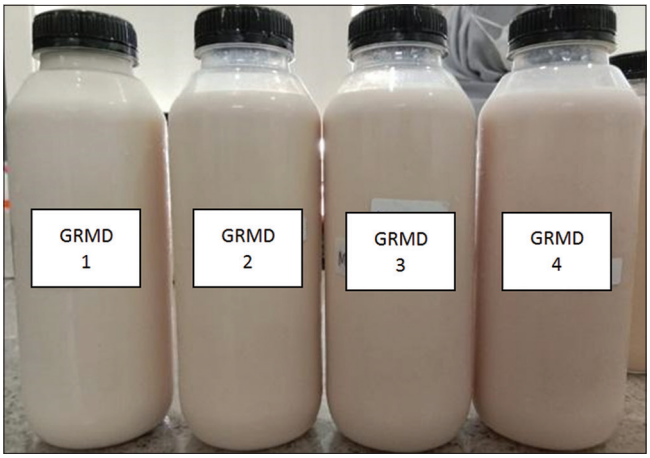

Figure 2: Guava rehydration milk drink (Source: Researcher's Private Collecyion)

The guava rehydration milk drink (GRMD) formula is made from full cream milk (71.9–80.6%), red guava (8.1–18.0%), red beans (9.0–10.1%), and fructose (1.1–1.2%), which were formulated by mixing the ingredients and then pasteurized at 63°C for 30 min. Table 1 shows that there is no difference

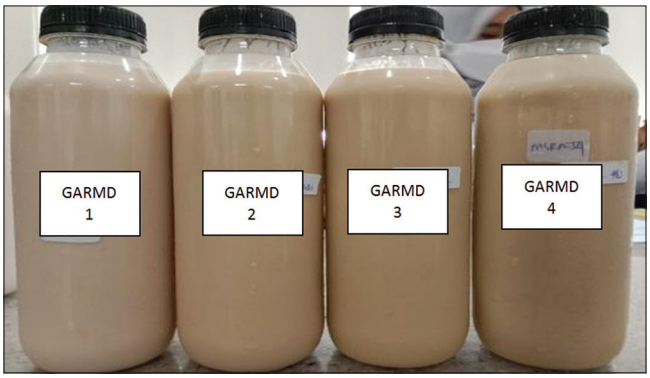

Figure 3: Guava avocado rehydrated milk drink (Source: Researcher's Private Collecyion)

in the organoleptic assessment of guava-rehydrated milk drinks on all organoleptic parameters. The highest average value, overall is the GRMD1 product (mean value 8.03).

The guava and ARMD (GARMD) formula is made from full cream milk (67.1%), avocado (6.7–16.8%), red guava (6.7–16.8%), red beans (8.4%), and fructose (1.0%), which were formulated by mixing the ingredients and then pasteurized at 63°C for 30 min. Table 1 shows that there is no difference in the organoleptic assessment of guava avocado rehydrated milk drinks in the parameters of color, odor, taste, and overall between variants, but there is a difference in texture ($p = 0.036$). *Post hoc* tests on textures showed variants of GARMD1 and GARMD3 ($p = 0.003$), variants of GARMD1 and GARMD4 ($p = 0.000$), variants of GARMD2 and GARMD3 ($p = 0.429$), variants of GARMD2 and GARMD4 ($p = 0.042$), and variants of GARMD3 and GARMD4 ($p = 0.135$). The highest average value overall was in the GARMD1 product (6.86).

Based on Table 1, it can be seen that statistically, there is no difference in organoleptic assessment between variants of each treatment on color parameters The highest mean values for organoleptic assessment of each treatment for the color parameter were ARMD2 (mean value 6.63), GRMD2 (mean value 7.21), and GARMD1 (mean value 6.51). Color is the first sensory that can be seen directly by the panelists. Determination of the quality of food ingredients generally depends on the color it has. Colors that do not deviate from the color that should be will give the impression of a separate assessment by the panelists [16]. Visually, sometimes, the color appears first and determines the quality of the food. Color can also be used as an indicator of freshness or maturity by knowing whether the mixing method or processing method is good or not, which can be determined by the uniformity of color [17].

Based on Table 1, it can be seen that statistically, there is no difference in organoleptic ratings between variants of each treatment on odor parameters. The highest mean values for organoleptic assessment of each treatment for the odor parameter were ARMD2 (mean value 6.43), GRMD1 (mean value 7.25), and GARMD1 (mean value 6.24). Odor is considered very important because it can quickly give results whether a food product is liked or not [18]. The odor determines the delicacy of food [17]. Odor is a stimulus that comes from substances that evaporate or dissolve in the air from food products and contact or come into contact with sensitive cells in the "olfactory" nasal cavity, causing a certain impression [16], [17], [19], [20].

Based on Table 1, it can be seen that statistically, there is no difference in organoleptic ratings between the variants of each treatment on taste parameters. The highest mean values for organoleptic assessment of each treatment for the taste parameter were ARMD1 (mean value 6.18), GRMD3 (mean value 7.42), and GARMD3 (mean value 5.72). Taste is a characteristic of a substance caused by the presence of parts of the substance that dissolve in water or oil or fat and come into contact with the sense of taste (tongue and oral cavity), thus giving a certain impression [19], [20]. Taste is influenced by several factors, namely, chemical compounds, temperature, concentration, and interactions with other taste components [17].

Based on Table 1, it can be seen that statistically, there is no difference in organoleptic assessment between variants of each treatment for texture parameters, except for texture parameters in guava avocado rehydrated milk drink. The highest mean value for organoleptic assessment of each treatment of the texture parameter was ARMD1 (mean value 6.25), GRMD3 (mean value 7.22), and GARMD1 (mean value 6.42). The texture is a sensation of stimulation that can be felt with the sense of touch, which is more sensitive to touch [18]. The texture is an attribute of food product assessment to determine whether it is solid or semisolid [20]. The texture of the food will affect the taste elicited by the food because it affects the speed of stimulation of olfactory receptor cells and salivary glands [17].

Based on Table 1, it can be seen that statistically, there is no difference in organoleptic assessment between variants of each treatment on all organoleptic parameters. The highest mean values for all organoleptic parameters for each treatment were ARMD1 (mean value 7.16), GRMD1 (mean value 8.03), and GARMD1 (mean value 6.86). The overall mean value is determined to be the best product of each treatment. Of the three treatments, GRMD had better scores compared to ARMD and GARMD. This is because GRMD products have a more attractive color, namely, light pink, and taste better than products containing avocado composition which has a bitter taste impression.

Nutritional content

The sensory quality of each beverage was assessed according to a method in which the osmolality ranged from 388 to 607 mosm/kg of water, the total polyphenol content was 27–49 mg GAE/100 mL and the Vitamin C content was 8.1–20.6 mg/kg. 100 mL, following the composition determined by the study results. Thus, it is possible to obtain quality beverage products [21]. The nutrient content per 100 g of each formulation with the highest average organoleptic rating

Table 2: The nutritional content of the best treatment rehydration milk drink

Characteristics tested	Formula (100 g)		
	ARMD1	GRMD1	GARMD1
Energy (kcal)	71.65	67.69	65.40
Carbohydrate (%)	7.38	8.04	7.31
Protein (%)	3.27	2.65	2.61
Fat (%)	3.23	2.77	2.86
Omega-3 fatty acids (mg)	27.95	15.45	26.95
Vitamin C (mg)	0	7.99	0
Sugar (%)	13.25	13.85	11.70

overall is presented in Table 2.

The highest energy of the three formulations is in ARMD1 of 71.65 kcal. Energy is needed by athletes to sustain life, support growth, and carry out physical activities [22]. Energy is obtained from macronutrients, namely, carbohydrates (4 kcal/g), fat (9 kcal/g), and protein (4 kcal/g) which are found in foodstuffs [17], [22], [23]. The highest carbohydrate of the three formulations was found in GRMD1 at 8.04%. Carbohydrates play an important role in determining the characteristics of food ingredients such as taste, color, texture, and others. In the body, carbohydrates play a role in preventing ketosis, namely, the excessive breakdown of protein in the body; preventing mineral loss and helping metabolize proteins and fats [17]. The highest protein of the three formulations was found in ARMD1 at 3.27%. Protein is a source of energy that the body can use if the energy needs of carbohydrates and fats are not met. Protein also acts as a builder and regulatory substance in the body [17]. The highest fat of the three formulations was found in ARMD1 at 3.23%. Fat is a more effective source of energy than carbohydrates and protein because it produces more energy. Fat in food ingredients plays a role in improving texture and taste [17].

The highest omega-3 fatty acids in the three formulations were found in ARMD1 of 27.95 mg. The content of omega-3 fatty acids in ARMD1 and GARMD1 comes from avocados. Avocados also contain protein, Vitamin D, and omega-3 polyunsaturated fatty acids (n-3 PUFAs) which are beneficial for skeletal muscle health [24]. In addition, omega-3 fatty acids and ascorbic acid accelerate the healing of colonic anastomosis [25].

The highest Vitamin C of the three formulations was found in GRMD1 of 7.99 mg. Vitamin C levels in the ARMD1 and GARMD1 formulas were undetectable or at levels <0.01 mg. The content of Vitamin C in the GRMD1 formula comes from guava with a Vitamin C content of 82 mg/100 g [26]. The content of Vitamin C in rehydration milk drink products is much lower than the content of Vitamin C in red guava fruit because the drink contains other ingredients with a large component such as milk, so the concentration of the guava ingredients is small which in turn has a smaller concentration of Vitamin C. Red guava is the fruit most liked by panelists [27]. Red guava is a fruit that is considered native to tropical America and is rich in Vitamin A, Vitamin C, iron, phosphorus and calcium, and other minerals [28]. The most important levels of Vitamin C are found in unpeeled guava. Guava also contains important levels of fundamentals such as oils, phenols, triterpenes, flavonoids, saponins, lectins, fiber, and unsaturated fats. In addition, the natural product has significant levels of minerals including phosphorus, calcium, iron, and vitamins, for example, niacin, pantothenic corrosive, thiamin, riboflavin, and Vitamin A. Guava is rich in two mixtures of carotenoids and polyphenols which give the natural product its antioxidant color making the product naturally one of the most important in terms of antioxidant value [29]. In addition to the high content of organic and inorganic compounds, guava has an antinociceptive activity which is effective against inflammation, liver damage, and serum production [11]. Consumption of food sources containing Vitamin C can help reduce the negative health burden caused by additional antioxidants [12]. Consumption of Vitamin C can be in the form of supplements. Vitamin C supplementation for 4 days effectively reduces exercise-induced tissue damage and inflammatory responses during and after the competition [30].

The results showed that the GARMD formula, which was a mixture of guava (containing Vitamin C) and avocado (containing omega-3), and milk, based on the analysis of the nutrient content of Vitamin C in the laboratory, was not detected different bond. Vitamin C is a natural antioxidant that can play a role in preventing lipid oxidation [31]. The incorporation of avocado pulp into milk increases the levels of protein, fat, ash, and crude fiber while having low water content and water activity indicates that it has a longer shelf life with low wettability time and dissolves directly in water [32]. Guava juice contains dominant aldehyde compounds, such as n-hexanal and eucalyptol alcohol. Twenty-four compounds were identified, including alcohols, sesquiterpenes, esters, and ketones, in guava fruit. Under different temperatures and vacuum conditions, the loss of Vitamin C is 15% to 55% for guava juice [33].

The highest sugar content of the three formulations was found in GRMD1 at 13.85%. The sugar in the rehydration milk drink comes from the added fructose syrup in the formulation, which also comes from avocado and red guava. Fructose is also known as fruit sugar. Fructose is a simple sugar (monosaccharide) consisting of six carbon atoms (hexoses) which is an isomer of glucose ($C_6H_{12}O_6$) and contains a carbonyl group as a ketone, which gives the fruit its sweet taste. Long-term consumption of fructose stimulates leptin resistance, causing obesity. Fructose is used as a sweetener in the form of high fructose corn syrup (HFCS). Fructose is used as a sweetener by the food industry because it has the sweetest taste among other types of carbohydrates, even 1.7 times sweeter than sucrose at a relatively cheap price. If the consumption of excess fructose can increase the symptoms of metabolic syndrome such as dyslipidemia, obesity, hypertension, hyperuricemia, and insulin resistance. Conversely, the consumption of small amounts of fructose has a positive effect on lowering blood glucose by increasing glucose uptake by the liver, stimulating hexokinase enzymes, and increasing insulin concentrations. Therefore, in 1986, HFCS was used as a sweetener for diabetics [34]. Giving fructose at a dose of 2%/kg BW increases fasting blood glucose and triglyceride levels higher than giving 1% kg BW [35]. Consumption of fructose that is safe for the body is no more than 5% of consumption

per day. High intake of fructose in drinks can increase the risk of diabetic nephropathy complications due to excessive use of Adenosine triphosphate in the process of fructose metabolism in the body [36].

The prevalence of impaired glucose tolerance (IGT) in the young age group in Indonesia is 5.7% and the prevalence of high fructose consumption is 20.5%. The contribution of high fructose consumption to the incidence of IGT at a young age is 24.3%. In general, the prevalence of IGT at a young age in Indonesia is quite high and consumption of high-fructose sweetened packaged drinks has a significant contribution to the occurrence of IGT [37].

Conclusion

The overall organoleptic assessment of parameters showed no differences between the variants of each treatment. The highest mean values for all organoleptic parameters for each treatment were ARMD1 (mean value 7.16), GRMD1 (mean value 8.03), and GARMD1 (mean value 6.86). The overall mean value is determined to be the best product of each treatment. Of the three treatments, GRMD1 had a better overall organoleptic mean score compared to ARMD1 and GARMD1. The nutritional content of GRMD1/100 g contains energy of 67.69 kcal, 8.04% carbohydrates, 2.65% protein, 2.77% fat, 15.45 mg omega-3 fatty acids, 7.99 mg Vitamin C, and 13.85% sugar.

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