

COMPARATIVE DETERMINATION OF SUGAR CONTENT IN VARIOUS BEVERAGES USING REFRACTOMETRY

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Annotation. *The modern diet is saturated with sugar-sweetened beverages, which are primary drivers of metabolic disorders and obesity. This study provides a comparative analysis of sugar concentrations in popular drinks using the refractometric method. The results revealed that "healthy" alternatives, such as strawberry yogurt (12.5% Brix) and freshly squeezed apple juice (11.7% Brix), contain significantly higher sugar levels than carbonated drinks like Coca-Cola (8.5% Brix). While natural juices provide essential vitamins and minerals, commercial dairy and instant products often harbor "hidden" added sugars that complicate dietary tracking. The findings highlight the necessity of distinguishing between natural and added sugars for better nutritional management.*

Keywords: *Refractometry, sugar concentration, Brix scale, hidden sugars, dietary health, sweetened beverages, metabolic risk.*

Annotatsiya. *Zamonaviy ovqatlanish odatlari, xususan shakar qo'shilgan ichimliklarning keng tarqalishi, ortiqcha vazn, qandli diabet va yurak-qon tomir kasalliklari kabi metabolik buzilishlarga sabab bo'ladi. Ushbu tadqiqotda turli ichimliklarda shakar miqdorini refraktometriya usuli yordamida solishtirish amalga oshirildi. Natijalar shuni ko'rsatdiki, "sog'lom" deb qabul qilingan mahsulotlar, masalan, qulupnayli yogurt (12,5 % Brix) va yangi siqilgan olma sharbati (11,7 % Brix), gazlangan ichimliklarga nisbatan (Coca-Cola – 8,5 % Brix) yuqori shakar tarkibiga ega. Tabiiy sharbatlar vitamin va minerallar bilan boy bo'lsa-da, tijorat yogurt va tez tayyorlanadigan ichimliklarda "yashirin" shakar mavjud bo'lib, kundalik ovqatlanishni nazorat qilishni murakkablashtiradi. Ushbu tadqiqot tabiiy va qo'shilgan shakarni ajratib ko'rsatishning muhimligini va ichimliklarni ongli iste'mol qilish zarurligini ta'kidlaydi.*

Kalit so'zlar: *Refraktometriya, shakar kontsentratsiyasi, Brix shkalasi, yashirin shakarlar, ovqatlanish salomatligi, shakarli ichimliklar, metabolik xavf.*

Аннотация. *Современные привычки питания, особенно потребление напитков с добавленным сахаром, являются основными факторами развития метаболических нарушений, ожирения и сердечно-сосудистых заболеваний. В данном исследовании проведён сравнительный анализ концентрации сахара в популярных напитках с использованием рефрактометрии. Результаты показали, что "здоровые" альтернативы, такие как клубничный йогурт (12,5 % Brix) и свежесвыжатый яблочный сок (11,7 % Brix), содержат значительно больше сахара, чем газированные напитки, например Coca-Cola (8,5 % Brix). Несмотря на то, что натуральные соки обеспечивают организм витаминами и минералами, коммерческие йогурты и готовые напитки*

часто содержат “скрытый” сахар, затрудняющий контроль ежедневного потребления. Исследование подчёркивает важность различия между натуральными и добавленными сахарами и необходимости осознанного выбора напитков.

***Ключевые слова:** Рефрактометрия, концентрация сахара, шкала Brix, скрытые сахара, здоровье питания, подслащенные напитки, метаболический риск.*

Introduction. Nutrition plays a decisive role in maintaining health, increasing life expectancy, and preserving human performance. The accelerated pace of modern civilization is accompanied by excessive intensity and duration of exposure to exo- and endogenic risk factors, including mental and emotional overload from a stream of negative information, excessive consumption of fatty foods, alcohol, and nicotine, coupled with limited physical activity, unbalanced nutrition, and accelerated biological aging. A modern lifestyle along with a changing one The diet has led to an increase in such diseases, such as type 2 diabetes, obesity, diseases of the cardiovascular system, oncological diseases, etc. Excess body weight, usually accompanied by the development of diabetes mellitus, is often associated with excessive consumption of high-calorie foods[1].

Recent studies show that free sugar intake in many countries comes to about 10 to 14 percent of total daily energy. In some countries, the amount even pushes past 70 to 85 grams for every person each day. Sugary drinks and sweet dairy products are among the main sources of added sugars, contributing to obesity, diabetes, and cardiovascular diseases. Epidemiological evidence suggests that regular consumption of sugar-sweetened beverages is a key driver of the global obesity epidemic and is specifically linked to an increased risk of metabolic syndrome[2].

The aim of this study was to determine the sugar concentration in different types of beverages using refractometry, and to compare their values with a natural standard — freshly squeezed apple juice.

Literature Review. Sugar-sweetened beverages have been recognized as a major contributor to the global rise in obesity, type 2 diabetes, and other metabolic disorders. The World Health Organization (2015) emphasizes that excessive sugar intake poses significant health risks and provides global recommendations for limiting sugar consumption in both adults and children. Epidemiological evidence presented by Hu and Malik (2010) further demonstrates a strong correlation between regular consumption of sugar-sweetened beverages and increased risk of obesity and type 2 diabetes, highlighting the need for monitoring sugar content in commonly consumed drinks.

Refractometry has been widely applied in food and agricultural industries to determine the concentration of dissolved solids, including sugars. Pozdeev (2022) describes practical applications of refractometry for measuring sugar content in liquids, demonstrating its reliability and ease of use. Similarly, Considine (1995) explains the scientific principles behind refractometry and its relevance for accurate determination of solute concentrations, which forms the methodological foundation of this study.

While sugar-free or artificially sweetened beverages are often perceived as healthier options, emerging evidence points to potential metabolic risks. Suez et al. (2014) report that artificial sweeteners can disrupt gut microbiota and impair glucose metabolism, suggesting that low-sugar drinks may not be entirely risk-free. Lustig (2013) underscores the concept of “hidden sugars” in processed foods and beverages, particularly in products marketed as healthy, such as flavored yogurts, which can contribute to unintentional excess sugar intake.

Furthermore, Berman, Ivanova, and Mikhaylova (2025) highlight the effects of various sugar substitutes on intestinal microflora and gastrointestinal function, particularly among young adults. Their findings emphasize the importance of distinguishing between naturally occurring sugars and added sugars in everyday diets. Together, these studies provide a strong rationale for analyzing the sugar content of different beverages and understanding their potential impact on health.

Materials and Methods. Refractometry is a method of studying substances based on determining the refractive index (coefficient of refraction) and some of its related properties[3]. Measurements were performed using a handheld refractometer at room temperature (approximately 22 °C). A refractometer is a device used to measure the refractive index of liquids. The refractometric method relies on the principle that the angle of refraction changes in proportion to the concentration of dissolved solids, providing a reliable Brix (°Bx) reading for aqueous solutions[4]. This measurement helps to determine the concentration of substances in a liquid, such as sugar, salts, or other dissolved solids. Refractometers are widely used in various industries, from food and beverage production to pharmaceuticals and agriculture, to ensure quality, stability, and safety. They are valued for their speed, accuracy, and ease of use, making them indispensable tools in both laboratory and field settings. Before measurements, the device was calibrated with distilled water ($n = 1.334$; 0.3 %). The following samples were analyzed: Distilled water (control), Coca-Cola, Coca-Cola Zero, Apple juice “Sochnaya Dolina” (commercial), Freshly squeezed apple juice, “Danone” strawberry yogurt, “MacCoffee” 3 in 1 instant coffee, “Nesquik” instant cocoa drink (for kids). For the yogurt sample, liquid serum was obtained by filtering through a multilayer gauze to remove solid fractions. Both the refractive index (n) and the percentage of dissolved solids (°Bx) were recorded.

Results.

	Beverages	Index of refraction (n)	Sugar concentration % (°Bx)
1	Distilled water	1.333	0.30
2	Coca-Cola (coke)	1.3485	8.50
3	Coca-Cola Zero	1.334	0.50
4	Apple juice “Sochnaya Dolina” (commercial)	1.3495	8.55
5	Freshly squeezed apple juice	1.359	11.70
6	Danone strawberry yogurt	1.365	12.50

7	“MacCoffee” 3 in 1 instant coffee	1.3515	9.75
8	“Nesquik” (instant cocoa drink)	1.340	4.0

Discussion. Coca-Cola showed approximately 8.5 % sugar, corresponding to around 21 g of sugar per 250 ml. In contrast, Coca-Cola Zero had only 0.5 %, (close to the percentage of sugar in water) yet remained sweet due to artificial sweeteners such as aspartame and acesulfame K. Studies show that frequent use of artificial sweeteners can cause disorders of carbohydrate metabolism and changes in intestinal microflora[5]. Drinking Coke regularly poses several health risks that deserve attention. The high sugar content is perhaps the most glaring issue. Excessive sugar intake is linked to obesity, type 2 diabetes, heart disease, and even certain cancers. A diet rich in sugary beverages like Coke can lead to weight gain due to empty calories: calories that don't provide nutritional value.

Commercial apple juice (“Sochnaya Dolina”) contained 8.55 % sugars, while freshly squeezed apple juice reached 11.7 %. The higher value is due to the presence of natural fructose and glucose. Despite the higher concentration, natural juice remains healthier because it also contains vitamins, pectins, and enzymes absent in processed products. Apple juice contains different types of sugar, such as fructose, glucose, and sucrose. Fructose is the most abundant sugar in apples and gives them their sweet taste. Glucose is another natural sugar that our body easily absorbs and uses for energy. Sucrose is a combination of fructose and glucose, commonly known as table sugar. The sugar in apples is mainly fructose, which is a healthier option compared to added sugars. Apple juice is rich in essential vitamins, such as vitamin C, which supports the immune system and helps maintain healthy skin. It also contains minerals like potassium, which is important for heart health and maintaining proper fluid balance in the body.

Commercially produced apple juice may contain added sugars that are not naturally present in the apples. These added sugars can include high fructose corn syrup or other sweeteners. It is important to check the label of apple juice to determine if any added sugars are present. Excessive consumption of added sugars can have negative health effects.

Danone strawberry yogurt showed the highest °Bx value (12.5 %), indicating a considerable amount of added sugar. The presence of high sugar levels in products marketed as 'healthy,' such as flavored yogurts, contributes to 'hidden' calorie intake, making it difficult for consumers to track their actual daily sugar consumption[6]. Strawberry yogurt is often seen as a healthy option, especially for children. but its sugar content can be a cause for concern. Yogurt naturally contains lactose, a type of sugar found in milk products; however, many flavored yogurts, including strawberry variants, have additional sugars added during processing. It's imperative to distinguish between

naturally occurring sugars and added sugars when considering the health implications of consuming strawberry yogurt.

Instant drinks like MacCoffee 3 in 1 at 9.75 percent and Nesquik with 4 percent showed some real differences. Sugary carbonated drinks and 3-in-1 coffee are among the main sources of added sugars in the diet of young people[7]. Those variations came down to the sugar to powder ratio in each one.

Conclusion. The highest values were observed in strawberry yogurt and fresh apple juice (12.5 % and 11.7 %), while Coca-Cola Zero had the lowest (0.5 %). Even though sugar-free drinks appear “safe,” artificial sweeteners may still pose health risks. The findings emphasize the importance of informed dietary choices and moderation in consuming sweetened beverages and dairy products.

References:

1. World Health Organization. Guideline: sugars intake for adults and children. – World Health Organization, 2015.
2. Hu, F. B., & Malik, V. S. Sugar-sweetened beverages and risk of obesity and type 2 diabetes: epidemiologic evidence. // *Physiology & Behavior*. — 2010. — Vol. 100. — P. 47–54.
3. Поздеев И. А. Практика применения прибора рефрактометра в продуктивном сельском хозяйстве // *ТЕНДЕНЦИИ РАЗВИТИЯ НАУКИ И ОБРАЗОВАНИЯ* Учредители: ИП Иванов Владислав Вячеславович. – С. 17-22.
4. Considine, D. M. Van Nostrand’s Scientific Encyclopedia. — 8th edition. — Springer, 1995.
5. Suez J., Korem T., Zeevi D. Artificial sweeteners induce glucose intolerance by altering the gut microbiota. // *Nature*. — 2014. — Vol. 514. — P. 181–186.
6. Lustig, R. H. *Fat Chance: Beating the Odds Against Sugar, Processed Food, Obesity, and Disease*. — Hudson Street Press, 2013.
7. Берман А. А., Иванова Р. А., Михайлова А. С. ВЛИЯНИЕ РАЗЛИЧНЫХ САХАРОЗАМЕНИТЕЛЕЙ НА МИКРОБИОТУ КИШЕЧНИКА И ФУНКЦИОНАЛЬНЫЕ НАРУШЕНИЯ ЖКТ У СТУДЕНТОВ-МЕДИКОВ // Состав редакционной коллегии и организационного комитета: Аймурзина БТ, доктор экономических наук Ахмедова НР, доктор искусствоведения Битокова СХ, доктор филологических наук Блинкова ЛП, доктор биологических наук. – 2025.