



FORMULATION OF ELECTROLYTE GUMMIES USING TENDER COCONUT WATER, LIME AND MANGO

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Abstract:

Electrolytes play an important role in maintaining hydration and supporting normal body functions, particularly during physical activity and conditions associated with fluid loss. This study focused on the formulation of electrolyte gummies using natural ingredients such as tender coconut water, lime, mango, banana, orange, and jaggery. The aim was to develop a convenient and appealing alternative to conventional electrolyte supplements while providing a simple way to support electrolyte replenishment. Different gummy formulations were prepared by varying the fruit-based ingredients and evaluated for their sensory characteristics, including appearance, taste, texture, and overall acceptability using a 5-point hedonic scale. Among the developed formulations, the gummy prepared with tender coconut water, lime juice, and jaggery showed the highest sensory acceptance, receiving a score of 5 for all evaluated parameters. Cost analysis was also carried out to assess the feasibility of the developed formulations. The findings suggest that natural fruit-based electrolyte gummies can serve as a convenient and enjoyable form of electrolyte supplementation, with good sensory acceptance and potential for further development as a functional food product.

Keywords: gummies; Tender coconut water; Lime juice; Mango; Jaggery; Hydration; Electrolyte replenishment; Functional food; Sensory evaluation; Natural ingredients

1. INTRODUCTION

The dietary supplement industry has transformed, offering consumers a vast array of choices. Initially, four basic forms existed: tablets, capsules, powders, and liquids. Today, options include soft gels, liquid caps, lozenges, gummies, and enteric coatings. Each delivery system has advantages depending on the nutraceutical and purpose. Gummies have emerged as a driver of market transformation, challenging traditional capsules and tablets. Industry experts and survey data identify key factors influencing functional gummy adoption, including hedonic values, "fun component," and flavor, enhancing consumption experience and contributing to positive attitudes. Functional gummies prioritize enjoyment over utilitarian values, distinguishing them from traditional supplements. (K.W. Andrews et al, 2018)

Furthermore, this paper examines market diffusion and consumer behavior using the theory of planned behavior. In this context, social norms, intention and attitudes prove to be significant influencing factors for the consumption of functional gummies. In addition, the findings emphasize the importance of trust, knowledge transfer and the perception of product quality for market penetration. (K.W. Andrews et al, 2017)

Proper hydration is vital for overall health, influencing neurological function, gastrointestinal and renal processes, body weight, and skin health. Electrolytes, including sodium, potassium, and magnesium, play a crucial role in maintaining hydration and electrical neutrality in cells. Imbalances can lead to life-threatening

issues, muscle weakness, and fatigue. While hydration and electrolyte balance are interconnected, they differ: dehydration refers to fluid deficiency, whereas electrolyte imbalance means excessive or inadequate levels. Sodium, essential for hydration, must be consumed in moderation (less than 2,300 mg/day) to avoid blood pressure risks. Maintaining optimal electrolyte balance is essential for general well-being, and electrolyte supplements can help reduce dehydration and water loss. However, evidence supporting hydration's health benefits is largely associative, and more randomized experiments are needed to understand the effects of minor hydration variations.(Sandeep Bhattarai, 2023)

OBJECTIVE

1. Identify and select suitable fruits based on their electrolyte content and compatibility for gummy formulation.
2. Develop formulations using the selected fruits to maximize electrolyte retention, taste, and texture.
3. Determine the optimal concentration of ingredients, including natural flavors, colors, and sweeteners, to enhance taste and nutritional value.
4. Adjust gelling agents and other stabilizers to achieve desired texture and chewiness of the gummies.
5. Conduct sensory tests to assess the taste, texture, appearance, and overall acceptability of the gummies.
6. Calculate the cost analysis of selected gummies

2. REVIEW OF LITERATURE

The project entitled “ **Formulation of electrolyte gummies**” was reviewed as:

- 2.1 The Importance of Electrolyte Replacement in Sports and Exercise
- 2.2 Gummy Candy Technology and Functional Foods
- 2.3 Existing Research on Electrolyte Gummies and Their Efficacy
- 2.4 Consumer Perception

2.1 The Importance of Electrolyte Replacement in Sports and Exercise

Prolonged exercise results in significant water and electrolyte losses due to sweating, which is vital for heat dissipation. The sweat rate is influenced by exercise intensity, environmental temperature, humidity, and individual differences. It can potentially exceed 2 L/h over extended periods.

Dehydration impairs exercise capacity and can jeopardize health. Fluid intake during exercise is essential for maintaining hydration. Effective hydration should balance fluid and electrolyte replenishment, particularly sodium and potassium. These minerals support water absorption and overall body function.

Water absorption in the small intestine is a passive process enhanced by glucose and sodium. Excessive fluid intake can lead to hyponatremia, which poses serious health risks.

Fluid replacement strategies should consider exercise duration and environmental conditions. Short-duration exercise (<30 minutes) may not require significant fluid intake. However, longer or high-intensity activity necessitates balanced hydration solutions that combine water, electrolytes, and carbohydrates.

The glucose concentration in hydration solutions should be low (20–30 g/L) for optimal water absorption. High sodium levels (up to 60 mmol/L) are needed for effective rehydration. More concentrated glucose solutions (150–200 g/L) are beneficial when carbohydrate provision is a priority. Frequent ingestion of small fluid volumes can optimize gastric emptying and maintain hydration. Athletes training in hot, humid conditions must prioritize hydration to prevent hypohydration. Hypohydration elevates core temperature and reduces the body's ability to dissipate heat.

Hypohydration can impair physiological functions, leading to reduced performance and an increased risk of heat-related illnesses. Heat-acclimated individuals should be vigilant about fluid replacement, as acclimatization increases sweat production. Failing to replace fluids can negate the benefits of acclimatization.

Electrolyte supplementation may not be necessary for individuals with balanced diets. However, it becomes crucial for athletes exposed to prolonged heat stress. Effective hydration protocols are essential for minimizing the limitations imposed by dehydration. Proper hydration ensures safe and productive athletic performance. Understanding the role of electrolyte balance and tailored fluid intake is crucial for sustaining physical endurance. It also helps in preventing heat-related complications and supports overall athlete health.(DeAnn Liska et al,2019)

2.2 Gummy Candy Technology and Functional Foods¶

Sweating, which is essential for heat dissipation, causes large losses of water and electrolytes during prolonged exercise. Exercise intensity, ambient temperature, humidity, and individual variances all affect perspiration rate. It may surpass 2 L/h for prolonged periods of time. Dehydration can endanger health and reduce one's ability to exercise. Drinking fluids while exercising is crucial to staying hydrated.

Hydration should balance the replenishment of fluids and electrolytes, especially potassium and salt. These minerals help the body absorb water and function as a whole.

Glucose and sodium facilitate the passive process of water absorption in the small intestine. Hyponatremia is a major health danger that can result from consuming too much fluid. Exercise duration and ambient factors should be taken into account when developing fluid replacement plans. Exercise that lasts less than 30 minutes might not necessitate a large fluid intake. However, balanced hydration solutions containing water, electrolytes, and carbohydrates are required for prolonged or high-intensity exercise.

For the best water absorption, hydration solutions should have a low glucose concentration (20–30 g/L). For successful rehydration, high salt levels (up to 60 mmol/L) are required. Prioritizing carbohydrate provision benefits from more concentrated glucose solutions (150–200 g/L). Maintaining hydration and optimizing stomach emptying can be achieved through frequent consumption of modest fluid quantities. Hydration must be a top priority for athletes training in hot, muggy weather in order to avoid hypohydration. The body's capacity to disperse heat is diminished and core temperature is raised when hypohydrated. Reduced performance and a higher risk of heat-related illnesses can result from hypohydration's impact on physiological processes. Because acclimatization increases sweat production, people who have been exposed to heat should be careful to replace lost fluids. If fluids are not replaced, the advantages of acclimatization may be lost.

People who eat a balanced diet might not need electrolyte supplements. For athletes who are subjected to extended heat stress, it becomes essential. Reducing the restrictions caused by dehydration requires the use of efficient hydration protocols. Drinking enough water guarantees safe and effective sports performance. Maintaining athletic endurance requires an understanding of the function of electrolyte balance and customized fluid intake. Additionally, it promotes the general health of athletes and helps avoid heat-related issues.(Michele Ross- 2024)

2.3 Existing Research on Electrolyte Gummies and Their Efficacy

Electrolyte gummies have become more and more popular in sports and health nutrition since they are frequently promoted as easy ways to get vital minerals and electrolytes. Electrolytes including potassium, sodium, calcium, and magnesium, which are essential for hydration, muscular contraction, and general cellular health, are frequently added to these candies. The potential advantages of electrolyte gummies are highlighted by research, particularly with regard to improving hydration and restoring minerals lost through exercise or dehydration.

Electrolyte Gummies and Hydration Efficiency: Research indicates that electrolyte gummies can promote hydration in a manner comparable to that of conventional electrolyte beverages, which makes them a sensible substitute for athletes and active people. Their small size makes it simple to consume them without the bulk of liquids, which is

especially helpful for activities where it is not practicable to bring fluids. These candies' mineral component, which is frequently sourced from salts and fruit, attempts to replenish vital electrolytes lost through perspiration, which may speed up recovery and preserve electrolyte balance.

Bioavailability and Absorption of Electrolytes: One of the most important factors influencing the efficacy of chewable electrolytes is their bioavailability. According to research, the chewable form may provide a more steady release of electrolytes by promoting slower absorption than liquid forms. Although additional comparative research is required to ascertain whether gummies equal the rapid absorption rates seen in liquid electrolyte supplements, this steady release can avoid spikes and maintain electrolyte levels.

Electrolytes from Natural Sources: Studies on gummies enhanced with natural components, such as fruit concentrates (like apple cider vinegar) or fruit vinegars, yield encouraging findings. Without the use of chemical additives, these natural sources can contribute nutrients like potassium and trace levels of natural carbohydrates. According to a study on gummies that had fruit vinegar added, natural ingredients raised the potassium levels in the candy, which may help with electrolyte replenishment. Furthermore, it has been demonstrated that some vinegars, such as apple cider vinegar, enhance the nutritional profile and texture of gummies, possibly offering a healthier substitute with less added sugar and more organic flavors and antioxidants.

Limitations and Needs for Further Research: Despite the fact that electrolyte gummies have a lot to offer, research has shown certain drawbacks. Certain nutrients, such as polyphenols and antioxidants, may lose some of their efficacy due to heat sensitivity during preparation, particularly if fruit-based ingredients are employed. Future studies could concentrate on investigating substitute gelling agents for vegan formulations and streamlining production procedures to preserve these heat-sensitive nutrients. To sum up, electrolyte gummies are a practical and efficient way to restore electrolytes, particularly when they are enhanced with naturally occurring ingredients like fruit vinegar. To properly evaluate their bioavailability in comparison to liquid supplements and to improve nutritional stability during manufacture, more research is necessary. (Namiki N, 1998)

2.4 Consumer Perception

Electrolyte gummies have gained popularity due to their convenient and enjoyable way of delivering essential nutrients, especially among health-conscious consumers, athletes, and those with active lifestyles. As gummy supplements become a staple in the functional nutrition market, research highlights that consumers appreciate their easy-to-use format, which many find preferable over more traditional electrolyte products like powders or tablets. This preference is driven by the appealing taste and texture that gummies offer, making them an accessible alternative to other dietary supplement forms.

One of the key aspects of electrolyte gummies' appeal lies in their blend of flavors and mouthfeel. Studies show that consumers are drawn to a range of flavors, from classic citrus to more exotic options like tropical fruits or herbal undertones such as lavender and mint. The texture of gummies is also highly valued; smooth, pectin-based gummies tend to be more popular than the firmer, gelatin-based varieties. This smoother texture aligns well with consumers' expectations for a pleasurable eating experience, leading to greater satisfaction and brand loyalty in this segment (Lee & Larson, 2023).

In addition to flavor and mouthfeel, many consumers view electrolyte gummies as a health-conscious choice, especially when they include clean labels and natural ingredients. There is a growing demand for gummies with minimal artificial additives, as consumers are increasingly looking for transparency and quality in health products. Brands that use natural sweeteners like honey or botanical extracts are often perceived more positively, adding a "health halo" effect. However, there remains some skepticism, especially around the sugar content in many gummies.

Although sugars and sweeteners improve taste, consumers are aware that these ingredients may counteract the health benefits being marketed (Johnson & Lee, 2024).

Electrolyte gummies also fill a unique market need by catering to individuals who have specific hydration and nutrient needs, such as athletes or people with conditions that require electrolyte replenishment, like Postural Orthostatic Tachycardia Syndrome (POTS). For these consumers, electrolyte gummies are appreciated not just for their portability but also for their convenience since they can be consumed without water. This portability makes gummies a practical option for those who prefer an easy-to-carry alternative to sports drinks or tablets, helping to expand the market as more brands enter the sector (Brown & Fisher, 2022).

Despite their popularity, the perception of electrolyte gummies as a premium health product is tempered by concerns about regulatory oversight within the supplement industry. This transparency is essential in building consumer trust and can differentiate high-quality products from those seen as lesser-quality or over-processed (Nutraceuticals World, 2023).

In summary, the consumer perception of electrolyte gummies is influenced by their sensory appeal, ingredient quality, and the convenience they provide. This market continues to grow as consumer interest in health-oriented and enjoyable supplement options rises. However, consumers remain cautious, particularly around transparency and quality, which creates opportunities for brands committed to trust and innovation in the electrolyte gummy segment.

3. RESULTS AND DISCUSSION

The result and discussion of the study entitled "Formulation and Shelf-life Analysis of Electrolyte gummies" is discussed as:

4.1 Sensory analysis

4.2 Shelf life study

4.3 Cost analysis

4.1 Sensory analysis

The sensory analysis was done for Variation I Control (tender coconut water gummies) Variation II (lime juice and mango puree gummies), Variation III (banana juice and orange juice gummies), Variation IV (lime juice gummies) and the results were discussed.

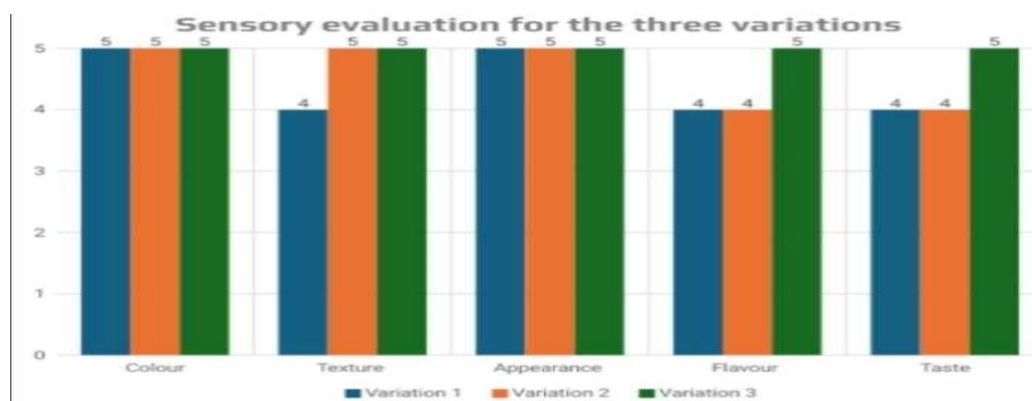


PLATE 4.1: BAR GRAPH ON SENSORY ANALYSIS OF THREE VARIATIONS OF GUMMIES

The graph represents the sensory analysis of different flavors (Tender coconut water, lime, mango and banana) paired with sweeteners (Jaggery). Each combination is evaluated on a 5-point hedonic scale, where higher values indicate greater preference.

Lime juice gummies had scored the highest. Lime juice and mango puree gummies and banana juice and orange juice gummies had scored good.

To conclude lime juice incorporated with tender coconut water and jaggery had scored the highest among all the flavors and natural sweeteners utilized. It had scored 5 (excellent) on all parameters.

4. CONCLUSION

Electrolyte-infused hydration gummies, rich in electrolytes and hydrating properties, have gained significant market traction due to their appealing appearance and functional benefits. These gummies, made from natural ingredients like tender coconut, jaggery, lemon, and orange, offer a convenient and delicious way to replenish electrolytes and hydrate the body. Recognizing the absence of electrolyte-specific gummy products in the market, we have developed a product that addresses this need, providing a unique and effective solution for hydration

References

- 1.Armstrong LE, Costill DL & Fink WJ (1985). Influence of diuretic-induced dehydration on competitive running performance. *Med Sci Sports Exerc* 17:456-461.
- 2.Buskirk ER, Lampietro PF & Bass DE (1958). Work performance after dehydration effect of physical conditioning and heat acclimatization. *J Appl Physiol* 12:189-194.
- 3.Danalakshmi J, Vasantharajan M, Subramanian E, Jeevanandan G. Changes in pH levels of saliva before and after taking chewable tablets. *Drug Invent Today*. 2018;10:3837–41.
- 4.Dille MJ, Hattrem MN, Draget KI. Bioactively filled gelatin gels; challenges and opportunities. *Food Hydrocoll*. 2018;76:17–29.
- 5.Dixit MA, Sen PS, Raut RG. *Soft-Chew Tablet Pharmaceutical Formulations*, 2022.
- 6.Dixit MA, Sen PS, Raut RG. *Soft-Chew Tablet Pharmaceutical Formulations*, 31 Dec 2023.
- 16.Electrolytes Are About More Than Just Hydration. Here Are 5 Key Benefits to Know, Michele Ross- 2024.
- 7.Electrolytes Isha Shrimanker and Sandeep Bhattarai. July 24, 2023
- 8.Fallowfield JL, Williams C & Singh R (1995). The influence of ingesting a carbohydrate-electrolyte beverage during 4 hours of recovery on subsequent endurance capacity. *Int J Spt Nutr* 5:285-299.
- 9.Farthing MJG (1988). History and rationale of oral rehydration and recent development in formulating an optimal solution *Drugs* 36:80-90 (suppl. 4).
10. Felig P, Cherif A, Minigawa A & Wahren J (1982). Hypoglycaemia during prolonged exercise in normal men. *New Eng J Med* 306:895-900.
- 11.Flynn MG, Costill DL, Hawley JA, Fink WJ & Neufer PD, Fielding RA & Sleeper MD (1987). Influence of skeletal carbohydrate drinks on cycling performance and glycogen use. *Med Sci Spt Exerc* 19:37-40.
- 12..Fortney SM, Nadel ER, Wenger CB & Bove JR (1981). Effect of blood volume on sweating rate and body fluids in exercising humans. *J Appl Physiol* 51:1594-1600.
- 13.Fortney SM, Wenger CB, Bove JR & Nadel ER (1984). Effect of hyperosmolality of control of blood flow and sweating. *J Appl Physiol* 57: 1688-1695.

- 14.H. Dai et al,2014,Effect of interaction between sorbitol and gelatin on gelatin properties and its mechanism under different citric acid concentrations,Food Chemistry.
- 15.Jacobs IC. Semi-solid Formulations. In: Bar-Shalom D, Rose K, editors. Pediatric Formulations: A Roadmap [Internet]. New York, NY: Springer; 2014. p. 171–9.
- 16.K.W. Andrews et al. Analytical ingredient content and variability of adult multivitamin/mineral products: national estimates for the Dietary Supplement Ingredient Database American Journal of Clinical Nutrition,(2017)
- 17.K.W. Andrews et al. Dietary supplement ingredient database (DSID) and the application of analytically based estimates of ingredient amount to intake calculations,Journal of Nutrition(2018) ,.
- 18.Michele TM, Knorr B, Vadas EB, Reiss TF. Safety of chewable tablets for children. J Asthma. 2002;39:391–403.
- 15.Namiki N, Takagi N, Yuasa H, Kanaya Y. Studies on development of dosage forms for pediatric use (V) oral mucosal irritation study of gummi drugs in hamster cheek pouch. Biol Pharm Bull. 1998;21:87–9.
- 19.Narrative Review of Hydration and Selected Health Outcomes in the General Population - DeAnn Liska et al ,2019.
- 20.Nishinari K, Fang Y, Rosenthal A. Human oral processing and texture profile analysis parameters: Bridging the gap between the sensory evaluation and the instrumental measurements. J Texture Stud. 2019.
- 21.Nyamweya N, Kimani S. Chewable tablets: a review of formulation considerations. Pharm Technol. 2020;44:38–44.
- 22.Physicochemical and textural properties of gummy candies prepared with fruit vinegar_ Rita Székelyhidi et al .2024
https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Electrolyte+in+gummies+&oq=ele#d=gs_qabs&t=1730451832966&u=%23p%3DauU0OjvNecJ
- 23.Rodríguez-Pombo L, Awad A, Basit AW, Alvarez-Lorenzo C, Goyanes A. Innovations in chewable formulations: the novelty and applications of 3D printing in drug product design. Pharmaceutics. 2022.
- 24.Sharma, V. M., Sridharan, K., Pichan, G., & Panwar, M. R. (1986). Influence of heat stress-induced dehydration on mental functions. Ergonomics, 29, 791–799.
- 25.Shirreffs, S. M., Armstrong, L. E., & Cheuvront, S. N. (2004a). Fluid and electrolyte needs for preparation and recovery from training and competition. Journal of Sports Sciences, 22, 57–63.
- 26..T.A. Comunian et al,2016, “Fabrication of solid lipid microcapsules containing ascorbic acid using a microfluidic technique,Food Chemistry
- 27.Taylor KM, Aulton ME, editors. Aulton’s pharmaceutics E-book: The design and manufacture of medicines. 6th ed. Elsevier Health Sciences, UK; 2021.
- 28.Taranum R, Mittapally S. Soft chewable drug delivery system: oral medicated jelly and soft chew. J Drug Deliv Ther. 2018;8:65–72.
- 29.United States Food and Drug Administration. FDA 101: Dietary Supplements. FDA. 2022.