Physiochemical properties of kids' candy (marshmallow) with *Beta vulgaris* and *Daucus carota* as a natural color

Eman Sh. A. Ghoname[1,*], Samah A. Abulmeaty[2],Heba A. Shaat[2], and Eman M. Hammad[2]

[1]*Special Food and Nutrition Department, Food Technology Research Institute, Agricultural Research Center, 12618 Giza, Egypt.*

[2]*Department of Food Science and Technology, Faculty of Agriculture (for Girls), Al-Azhar University, 11884 Cairo, Egypt.*

[*] Corresponding author E-mail: Emanghoname2020@gmail.com (E. Ghoname)

ABSTRACT:

Marshmallows are among the oldest confections known to humankind. In today's world, there is a growing trend towards maximizing the use of natural sources in food processing while avoiding artificial colors and flavors. The market currently offers a diverse range of confectionery products, which, although integral to the human diet, tend to have low nutritional value and high energy content. This research focuses on producing marshmallows using natural sources for both color and flavor, such as red beet (*Beta vulgaris* L.) and carrot (*Daucuscarota*L.). Marshmallows made with red beet and carrot juices demonstrated improvements in nutritional value, physical parameters, color, mineral content, antioxidant activity, and sensory evaluation. The orange marshmallow (carrot) exhibited the highest calcium and selenium content (532.65 and 0.74 mg/kg), whereas the marshmallow with red beet juice had higher levels of iron, magnesium, and zinc compared to other treatments. The antioxidant capacity for red beet samples was 63.31%, surpassing other samples. The lowest antioxidant activity was found in the imported control sample (1) at 44.30%, but its vitamin content (vitamin C 23 mg and vitamin E 1.30 mg) was higher than other samples. Sensory evaluation results revealed no significant differences in flavor and texture among the samples, except for the marshmallow with red beet juice, which scored lower. Producing marshmallows with natural juices is economical and applicable, making it as a natural and healthy food coloring.

Key words: Marshmallow; natural color/flavor; red beet-root carrot; natural antioxidant.

INTRODUCTION

Marshmallows are among the oldest sweets known to humanity, belonging to popular confectionery items. They are a unique type of chewable soufflé made primarily from sugar and gelatin. Today, there is a global trend toward using natural ingredients in food production, avoiding artificial colors and flavors. The technical and economic feasibility of producing various types of marshmallows from fruit and vegetable juices has gained widespread acceptance among diverse consumers worldwide. These newly developed marshmallows, made from natural local raw materials, are high-quality products that address deficiencies in iron, zinc, calcium, and magnesium for children (Ali, 2020).

Color plays a crucial role in determining the quality and nutritional value of foods. In the food industry, colored additives are extensively used to make products more visually appealing to consumers. However, these additives can pose health risks if consumed excessively. To address this, methods have been developed to add artificial colorants to foods safely. These methods involve using various techniques and following protocols to prepare samples that are safe for human consumption (Pham *et al.*, 2020; Ntrallou *et al.*, 2020).

Consumer preferences have increasingly shifted towards healthier foods that are rich in natural dietary fibers, antioxidants, vitamins, minerals, and low in calories and fats, without the inclusion of artificial color additives. As a result, carrot juice has been utilized to create gelatinous candies that are nutrient-dense and offer functional benefits, such as the presence of beta-carotene, which provides numerous nutritional advantages to consumers. On the other hand, synthetic food colors are chemical compounds not found in nature, created through human processes. These water-soluble colors are commonly added to foods without the need for further processing (Achumi*et al.*, 2018).

Bio colorants used in food include anthocyanidins, carotenoids, flavonoids, chlorophyll, crocin, and betalains, all of which are derived from various horticultural plants. Beyond their role as colorants, these natural compounds also provide antimicrobial and antioxidant benefits, helping to prevent various diseases and health conditions. However, despite their potential, the adoption of bio colorants is limited by factors such as complex extraction methods, lower color intensity, higher costs compared to synthetic dyes, and instability during food processing. The functionality of food is greatly influenced by some of its bioactive compounds (Asghari*et al*., 2020).

Beet root (*Beta vulgaris* L.), a flowering plant from the Chenopodiaceous family, is widely cultivated in the Mediterranean, Europe, and Asia Minor, and has been traditionally used in folk medicine (de Oliveira *et al*., 2023). Beetroot is rich in pigments such as betaxanthins and betacyanins, which are part of the betalain family. These pigments are water-soluble, nitrogen-containing compounds derived from betalamic acid. Extensive research has shown that betalains in beetroots have health-promoting properties, including antioxidative, anti-inflammatory, and antitumor effects. (Awad *et al*., 2024).

Although beetroot is high in sugar, it is low in calories and contains a wealth of antioxidants, vitamin C, and betalains. The deep red beetroot roots are also rich in carotenoids, saponins, betanins, polyphenols, and flavonoids. Regular consumption of beetroot has been shown to help prevent the growth of cancer cells, thereby offering protection against cancer. Beetroot is commonly used in various food products such as baked goods, sweets, and ice cream (Neha*et al*., 2018).

The carrot, a root vegetable renowned for its high nutritional value and health benefits, is particularly celebrated for its rich antioxidant content, especially carotenoids, which are associated with cancer-fighting properties. These antioxidants, along with polyphenols and vitamins found in carrots, are known to have anticarcinogenic, antioxidant, and immune-boosting effects, supporting the long-standing belief that carrots are beneficial for eye health. Carotenoids and flavonoids, which give carrots their distinctive color, also contribute to their antioxidant activity. Research has extensively explored the role of various carotenes, especially β-carotene, in providing pro-vitamin A. Vitamin A deficiency remains a leading cause of early childhood mortality, and since carrots are a rich source of β-carotene, which the body easily converts into vitamin A, they play a critical role in addressing this issue. Given the significant dietary and health advantages, it is crucial to focus on developing and marketing products that help meet people's nutritional needs, especially as an affordable source of vitamin A (Ikrama *et al*., 2024). Marshmallows, chewy treats made from sugar, water, flavoring, and gelatin, are traditionally colored using artificial dyes. However, there is a growing trend toward replacing these artificial colors with natural alternatives to ensure better safety for consumers. Among these natural options, carrots have emerged as a promising source of natural colorant (Rofianatul *et al*., 2023). The aim of this study was to evaluate the use of beet and carrot juices as natural colorants in soft candies (marshmallows). The investigation included physicochemical analyses, physical properties, and consumer acceptance to produce candies with natural red and yellow colors, resulting in a healthier, more natural product.

MATERIALS AND METHODS

Materials:

The raw materials used in these experiments were purchased from local markets. Fresh vegetables, including red beet (*Beta vulgaris*) and carrot (*Daucus carota*), were used in their juice form. A blank sample was prepared without any juice or color for comparison. Artificial marshmallows, both local and imported, were purchased from supermarkets in Tanta City, El-Gharbia Governorate, Egypt. Other ingredients included glucose syrup (30-32DE) from National Co. for Maize Products (10th of Ramadan City, Egypt), commercial-grade granulated sugar cane (sucrose) from the Egyptian Sugar and Integrated Industries Company (Hawmdia City, Egypt), gelatin powder, sodium chloride (food grade), and corn starch, all sourced from the local market in Tanta City, El-Gharbia Governorate, Egypt.

Methods

Preparation of Natural Juice Extracts:

Red beet (*Beta vulgaris*) and carrot (*Daucus carota*) were washed, peeled, and mashed into pulp using an electric carrot machine mixer (Barun, Combimax 700, Germany). The pulp was then filtered to obtain juice, which was used in the experiments. A blank sample was also prepared for comparison. Both imported and local artificial marshmallows were used as controls.

Preparation of Marshmallows (Kids' Candy):

Marshmallows were prepared following the recipe outlined in Table 1. Gelatin was soaked in warm water (45°C). The sugar, glucose syrup, sodium chloride, and remaining water were heated, and the mixture's brix value was adjusted to 73 -84°B by adding water. Control samples consisted of local and imported marshmallows. For the experimental marshmallows, an additional 10 g of natural red beet or carrot juice per 100g of the marshmallow mixture was incorporated as part of the water used. The mixture was poured into cylindrical molds, allowed to cool overnight, and cut into 3 cm pieces, following the procedure from El-Mesiry*et al*., (2021).

Analytical Methods

Physical and Chemical Composition:

The moisture content, total soluble solids, ash, minerals, total sugars, reducing sugars, and non-reducing sugars were determined using methods outlined in AOAC (2019).

Minerals Content:

The mineral content (calcium, zinc, selenium, iron, and manganese) of tasted sample was analyzed using Atomic Absorption Spectrophotometry (Perkin Elmer, Model 3300, Germany), According to AOAC (2023).

Vitamins Content:

Vitamin E (α-tocopherol) was determined by High-Performance Liquid Chromatography (HPLC) as described by Asran *et al*., (2023).Vitamin C content was measured by mixing the marshmallow extract with trichloro acetic acid (TCA) and dinitrophenyl hydrazine (DNPH) before incubating and measuring absorbance at 520 nm, by the method described by Timoshnikov *et al*., (2020).

Non-Enzymatic Browning (Color Index at 420 nm):

The increases in absorbance at 440 nm was used to assess non-enzymatic browning. Extracted samples were treated with alcohol and benzene to remove chlorophyll, then measured for color intensity at 440 nm, was carried out FSSAI (2016).

Color Measurement:

The color intensity of the samples was analyzed using a JENWAY 6705 UV/V Spectrophotometer, measuring wavelengths from 400-700 nm, based on the method of FSSAI (2016).

Antioxidant Activity (DPPH%):

Free radical scavenging was assessed by the discoloration of a DPPH ethanol solution, as described by Aromatic *et al*., (2013).

The Texture Profile Analysis:

The texture profile analysis, including hardness, cohesiveness, springiness, gumminess, and chewiness, was analyzed using a Universal Testing Machine (TMS-Pro, Food Technology Corporation, Sterling, VA, USA) with a 1000 N load cell and Texture Pro™ software, based on the methods of Andreania*et al.,* (2020) and Bernardo *et al.,* (2022)

Water Activity (aw):

Water activity was measured using the chilled mirror dew point method, providing accurate readings in less than five minutes as described by Zhang *et al.,* (2015).

Reconstitution of Marshmallows:

Reconstitution was determined by adding water to dried marshmallow samples, heating, and draining to calculate the reconstitution ratio (%) according to Tiwari and Sardar (2020).

Sensory Evaluation:

Sensory attributes such as color, taste, flavor, texture, and overall acceptability were evaluated using a 10-point hedonic scale by ten panelists from the Food Technology Research Institute. Samples were rated from "I don't like it" (1) to "I like it very much" (10), as described by Rodrigues *et al.,* (2024).

Statistical Analysis:

Data were analyzed using the General Linear Model (GLM) procedure of Analysis of Variance (ANOVA) as outlined by Willard (2020). Means were separated using Duncan's test at a significance level of $P \leq 0.05$. Statistical analyses were performed using SAS software (SAS, 2020).

RESULTS AND DISCUSSION

The data in Table (2) showed that the total solids content decrease from 82.94% in the control sample to 73.49% in the orange marshmallow sample. This reduction indicates that the incorporation of natural juices from beet and carrot has led to a denser product, which may enhance shelf stability and texture. Conversely, moisture increased from 17.06% in the control to 26.51% in the orange marshmallow. This increase is crucial, as higher total solids can contribute to improved mouthfeel and overall quality of the product. The total soluble solids rose significantly from 55.03 % in control to 60.93% in orange marshmallow, indicating that the natural juices not only add flavor but also enhance the nutritional profile of the marshmallows. Total sugars showed a notable increase in red beet marshmallow sample (57.28) meanwhile the control samples measuring 49.15, 51.93, and 49.39% for controls 1, 2, and blank respectively. This increase suggests that the natural juices contribute additional sugars, enhancing sweetness without relying on artificial sweeteners. Reducing sugars increased dramatically from 10.03% in orange marshmallow to 44.05% in red beet marshmallow, while control samples recorded values of 32.99%, 29.45%, and 15.28% for controls 1, 2, and blank respectively. The high level of reducing sugars in the red beet marshmallow sample may indicate a higher degree of caramelization during processing, which can improve flavor complexity. Overall, these results underscore the potential of using natural juices as effective colorants and sweeteners in marshmallow production, contributing to both sensory appeal and nutritional enhancement while reducing reliance on artificial ingredients. These results were in agreement with Ali *et al*., (2017) who reported that producing marshmallows by using natural sources for both of color and flavor such as golden berry and red beet-roots. It is proper, successful, economic and applicable to produce two kinds of marshmallows with natural color and flavor which are very suitable to be taken as a good natural confectionery of healthy food coloring.

Ash content showed a significant increase in both the red and orange marshmallow samples compared to the other samples. These findings are consistent with Periche *et al*. (2015)**,** who reported that processed marshmallow products containing fruit and vegetable juices are nutritionally valuable and can be a good source of minerals and vitamins.

Physical Parameters of Marshmallow Products

Color plays a crucial role in consumer acceptance of food products, which has led to a decline in synthetic colorant use in favor of natural colorants. Data in Table **(3)** demonstrated significant differences in color across all marshmallow samples. The test indicated that the red beetroot marshmallow juice had the highest color score, followed by the orange carrot marshmallow, while the blank sample had the lowest score. Plant-based natural pigments are preferred not only because they are readily available as colorants but also due to their health-promoting properties, including antioxidants and antimicrobial activity, which are beneficial to human health (Mohd-Nasir *et al*., 2018).

Antioxidant Activity and Vitamins in Marshmallow Products

The results in Table (4) showed the antioxidant activity and vitamins content in the marshmallow samples. The treatments containing fruit juices had higher antioxidant activity, especially the red beetroot (63.31%) and carrot juice (58.85%). The lowest antioxidant activity was observed in the imported control (1) at 44.30%, while the blank (55.43%) and local control (2) (45.15%) showed intermediate values. Additionally, the marshmallows treated with red beet and carrot juices had the highest vitamin content compared to the other samples.

These results suggested that the highest antioxidant and phytochemical content in red beetroot and carrot juices enhances the antioxidant activity in marshmallows. This is in agreement with Ikrama *et al*. (2024), who noted that carotenoids and flavonoids, which give carrots their color, also provide antioxidant properties. Moreover, Awad *et al.* (2024) highlighted that beetroots are rich in pigments such as betaxanthins and betacyanins, which belong to the betalain family. Numerous studies have shown that these compounds offer health-protective benefits, including antioxidant, anti-inflammatory, and antitumor effects. In conclusion, these findings indicate that carrot and beetroot juices, which are rich in antioxidants, can be used to enhance the nutritional value of food products like marshmallows. They provide a cost-effective way to improve the health benefits of such products.

Mineral Content in Marshmallow Products

According to data from Table (5), the minerals content of the marshmallow products varied across the different samples. The Orange Marshmallow (made with carrot juice) exhibited the highest levels of calcium and selenium, with values of 532.65 mg/kg and 0.74 mg/kg, respectively. On the other hand, the marshmallow containing red beetroot juice had the highest concentrations of iron (Fe), magnesium (Mg), and zinc (Zn) compared to the other samples. The control sample (1) showed the lowest mineral content. The higher calcium and iron ratios in the marshmallows are likely due to the inclusion of beetroot and carrot, which are rich in natural pigments like anthocyanin and beta-carotene. These findings align with the research by Ali (2020), which suggested that marshmallows made with fruit and vegetable juices offer high nutritional value, addressing deficiencies in iron, zinc, calcium, and magnesium, particularly for children.

Texture Profile and Water Activity of Marshmallow Products

Table (6) presented data on the texture profile attributes, including hardness, adhesiveness, springiness, cohesiveness, gumminess, and chewiness. The physical structure of the marshmallows is influenced by water activity, which affects the product's transition from a rubbery to a glassy state due to moisture content. There was minimal difference in hardness between the samples, with Orange Marshmallow (carrot) performing the best. It is a factor that is used to evaluate the mouth feel and is defined as the force required attaining a given deformation (Garrido *et al.,* 2014). Significant differences were observed in adhesiveness, with marshmallows made from red beetroot juice and Orange Marshmallow (carrot) showing the highest adhesiveness, indicating a better product quality. Adhesiveness, or stickiness, refers to the effort required to overcome the attractive forces between the surface of the food and the material (Mutlu *et al.,* 2018).

In terms of springiness, Orange Marshmallow (carrot) and the red beetroot juice marshmallows had the highest values. Springiness is inversely related to hardness, meaning that as firmness increases, elasticity decreases (Kreungngern and Chaikham, 2016). Similarly, significant differences were found in cohesiveness, with the highest value in Orange Marshmallow (carrot). The gumminess value was highest in the red beetroot juice marshmallow, followed by Orange Marshmallow (carrot), indicating that a firmer jelly requires more energy to break down for swallowing (Mutlu *et al.,* 2018). When it comes to chewiness, red beetroot juice marshmallows scored the highest, which, like gumminess, increases with higher hardness (Mutlu *et al.,* 2018). Regarding water activity (aw), both the Orange Marshmallow (carrot) and red beetroot juice samples showed the highest values, indicating lower quality compared to the control samples (1 and 2), which had better water activity values.

Reconstitution Ratio of Marshmallow Products

Table (7) illustrated that the rehydration times of the marshmallow products. The control sample (commercial marshmallow) showed an increase in water absorption with longer soaking times, contrary to the expected decrease in rehydration time as soaking progressed.

Sensory Evaluation of Taste Marshmallow Products

According to the sensory evaluation data from Table (8) and Figure (1), marshmallows made from natural carrot and beetroot juices were all found to be acceptable by consumers. There was minimal difference in overall liking between the control (commercial) sample and those made with carrot and beetroot juices.

The red beetroot marshmallow received the highest score for appearance, while the Orange Marshmallow (carrot) was rated the highest in color. In terms of flavor and texture, no significant differences were found across the samples, except for the beetroot juice marshmallow, which had a slightly lower flavor score. Taste scores also showed no significant difference, except for a slight decrease in the beetroot juice sample. These results are consistent with the findings of Ali *et al*. (2017), who reported that marshmallows made with fruit and vegetable juices provide similar sensory characteristics to those made with artificial colors and flavors.

Marshmallow Control

10% red beat

10% Carrot juice

Figure 1: Marshmallow made from red beat and carrot

CONCLUSION

In conclusion, marshmallows made with red beetroot and carrot juices present a technically and economically viable alternative to traditional marshmallow production. These natural products offer high palatability among diverse consumer groups and help address nutritional deficiencies in iron, zinc, calcium, and magnesium, particularly for children. The marshmallows made from these natural juices have similar color and aroma to those produced with artificial additives. The phytochemical analysis of these marshmallows reveals them to be rich in total phenolic compounds and flavonoids, which offer antioxidant properties, boost the immune system, and contribute to overall health benefits. The positive consumer acceptance across all categories suggests that these products can be successfully marketed as a healthier alternative.

REFERENCES

Achumi, L.V., Peter, S., Das, A. 2018: Studies on preparation of gummy candy using pineapple juice and carrot juice, International Journal of Chemical Studies; 6(5): 1015-1018.

Ali, Nesreen, M.E. 2020: Production of marshmallow sweets free of golden syrup using some Fruits and vegetables juices. Bull. Fac. Agric., Cairo Univ., 71: 297-3 06.

Ali, Nesreen M.E., Al-Askalany, Samia.A., Ghandor, Hana.M. 2017:Evaluation of Sensory, Physicochemical Changes of Marshmallow (Children Candy) by Addition Natural colors. Bulletin of the National Nutrition Institute of the Arab Republic of Egypt, 50(1): 219-243.

Andreania, P., de Moraesa, J.O., Murtab, B.H.P., Linka, J.V., Tribuzic, G., Laurindoa, J.B., Paulb, S., Carciofia, B.A.M. 2020:Spectrum crispness sensory scale correlation with instrumental acoustic high-sampling rate and mechanical analyses. *Food Research International, 129*.https://doi.org/10.1016/j.foodres.2019.108886.

AOAC. 2019: Official Methods of Analysis of the Association of Official Analytical Chemists: Official Methods of Analysis of AOAC International. 21st Edition, AOAC, Washington DC.

AOAC. 2023: Association of Official Analytical Chemists. *Official methods of analysis* (22nd ed.). Gaithersburg, MD, USA:

Aromatic, F.A., Elmhdwi, M.F.; Aromatic, F.,Aromatic, O.O. 2013: Estimation of antioxidant activities of fixed and volatile oils extracted from Aromatic aromatic (clove).Der ChemicaSinica, 4(3):120-125.

Asghari, A.A.,Mokhtari-Zaer, A.,Niazmand, S.,McEntee, K.,Mahmoudabady, M. 2020: Anti-diabetic properties and bioactive compounds of Teucriumpolium L. Asian Pacific Journal of Tropical Biomedicine, 10(10): 433- 441.

Asran, A.R., Ali, H.E., Gahly, M.S. 2023: Determination of tocopherols, total phenolic compounds and antioxidant activity of some nonconventional vegetable oils. *Al-Azhar Journal of Agricultural Research,* Vol. (Special issue), October (2023) (416-426).

Awad, E.S., Abdelzaher, M.F., Abbas, W.T., Darwish, D.A., Abdel-Monsef, M., Younes, A.M., Gaafar, A.Y. 2024: Effect of Beetroot (Beta vulgaris L.) Extract on Enhancing the Immune Status and Antioxidant Enzymes of the Nile tilapia (Oreochromisniloticus) Exposed to Lead. *Egyptian Journal of Aquatic Biology and Fisheries*, *28*(3):439 – 459.

Bernardo, Y.A. de A., do Rosario, D.K.A., Monteiro, M.L.G., Mano, S.B., Delgado, I.F., Conte Junior, C.A. 2022:Texture profile analysis: How parameter settings affect the instrumental texture characteristics of fish fillets stored under refrigeration? Food Analytical Methods, *15*,144–156.https://doi.org/10.1007/s12161-021-02095-0.

Daily-Intake, F.D.A. 2020: Interactive Nutrition Fact Label _Vitamins and Minerals Chart (1)_March, (2020). FDA.U.S. Food and Drug Administration.
www.fda.gov/nutritioneducation

De Oliveira, S.P.A., do Nascimento, H.M.A., Rodrigues, N.P.A., Sampaio, K.B., dos Santos Lima, M., da Conceição, M.L., leite de Souza, E. 2023:Different parts from the whole red beet (*Beta vulgaris* L.) valorization with stimulatory effects on probiotic lactobacilli and protection against gastrointestinal conditions. Food Bioscience, 52: 102439.

de Oliveira, S.P.A., do Nascimento, H.M.A., Rodrigues, N.P.A., Sampaio, K.B., dos Santos Lima, M., da Conceição, M.L.,leite de Souza, E. 2023: Different parts from the whole red beet (Beta vulgaris L.) valorization with stimulatory effects on probiotic lactobacilli and protection against gastrointestinal conditions. Food Bioscience, 52: 102439.

El-Mesiry, Dalia M., El Desoky, Soad M.,Abd El-Razek, Rabab H.,Ahmed, M.F. 2021: Characteristics of Children Marshmallow Candy Colored by Natural Anthocyanin Extract from Jamun (Syzygiumcumini) during Cold Storage. Journal of Food and Dairy Sciences and Dairy Sci., Vol., 12 (8): 189 -194.

FSSAI. 2016: Food Safety and Standards Authority of India (FSSAI). *Manual of analysis of fruit and vegetable products.* FDA Bhawan, Kotla Road, New Delhi-110002, India.

Garrido, J.I., Lozano, J.E.,Genovese, D.B. 2014: Effect of formulation variables on rheology, texture, colour, and acceptability of apple jelly: Modelling and optimization. LWT - Food Science and Technology, *62* (1), 325-332 http://doi.org/10.1016/j.lwt.2014.07.010.

Ikrama, A., Rasheeda, A.,Khana, A.A.,Khana, R., Ahmada, M.,Bashirb, R.,Mohamed, H.M.2024: Exploring the health benefits and utility of carrots and carrot pomace: a systematic review. Nternational journal of food properties, VOL. 27, NO.1, 180–193 https://doi.org/10.1080/10942912.2023.2301569.

Kreungngern, D.,Chaikham, P. 2016: Rheological, physical and sensory attributes of Chao Kuay jelly added with gelling agents. International Food Research Journal, 23(4), 1474–1478.

Mohd-Nasir, H.,Abd-Talib, N.,Mohd-Setapar, S.H., Wong, LG.,Idham, Z., Casillas, A.Z., Ahmad, A. 2018: Natural colorants from plants for wellness industry, International journal of pharmaceutical sciences and research, 9(3), 836- 843.

Mutlu, C., Tontul, S.A.,Erbaş, M. 2018: Production of a minimally processed jelly candy for children using honey instead of sugar. LWT http://doi.org/10.1016/j.lwt.2018.03.064.

Neha, P., Jain, S.K., Jain, N.K., Jain, H.K.,Mittal, H.K. 2018: Chemical and review. International Journal of Chemical Studies, 6(3), 3190–3194.

Ntrallou, K.,Gika, H., Tsochatzi, E. 2020: Analytical and Sample Preparation Techniques for the Determination of Food Colorants in Food Matrices, Foods, 9(1), 58; 1-24, doi:10.3390/foods9010058.

Periche, A., Heredia, A., Escriche, I., Andrés, A., Castelló, M.L. 2015: Potential use of isomaltulose to produce healthier marshmallows. *LWT-Food Science and Technology*, *62*(1), 605-612.

Pham, D.T., Ninh, N.T., Hoang, T.N., Pham, C.T.K., Nguyen, L.H., Tran, T.Q.,Huynh, D.T.T. 2020: The Effectiveness of Oral Nutritional Supplements Improves the Micronutrient Deficiency of Vietnamese Children with Stunting. Archives of Pharmacy Practice, 11(1), 7-13.

Rodrigues, S.S.Q., Dias, L.G., Teixeira, A. 2024: Emerging methods for the evaluation of sensory quality of food: Technology at service. Current Food Science and Technology Reports.*2*(1), 77-90.https://doi.org/10.1007/s43555-024-00019-7.

RofianatulJannah, N., Ekawati, I.G.A., KartikaPratiwi, I.D.P. 2023: Pengaruh PenambahanSari Wortel (*Daucus carrota* L.) terhadapKarakteristik Marshmallow. JurnalIlmudanTeknologiPangan (ITEPA), 12(3), 563-574.ISSN 2527-8010.

SAS Institute Inc. 2020: SAS/STAT® 15.2 User's Guide, Statistics. Cary, NC: SAS Institute Inc.

Timoshnikov, V.A., Kobzeva, T.V., Polyakov, N.E., Kontoghiorghes, G.J. 2020: Redox interactions of vitamin C and iron: Inhibition of the pro-oxidant activity by deferiprone. *International Journal of Molecular Sciences, 21(11),* (3967).https://doi.org/10.3390/ijms21113967.

Tiwari, M., Sardar, N. 2020: Concentration, drying and dehydration. Food Processing and Preservation.Retrieved from https://www.researchgate.net/publication/355873331.

Willard, C.A. 2020:*Statistical methods: An introduction to basic statistical concepts and analysis* (2nd ed.). Routledge, Taylor & Francis Group.https://doi.org/10.4324/9780429261039.

Zhang, L., Sun, D.W., Zhang, Z. 2015: Methods for measuring water activity (aw) of foods and its applications to moisture sorption isotherm studies. *Critical Reviews in Food Science and Nutrition. 57(5), 1052-1058.*https://doi.org/10.1080/10408398.2015.1108282.

Table 1: Formulae of produced marshmallow (kids' candy)

Main Ingredients (%)	Control marshmallow	Carrot marshmallow	Red beet marshmallow
Gelatin	10.30	10.30	10.30
Water to soak gelatin	12.74	12.74	12.74
Sugar	45.09	45.09	45.09
Water	29.81	19.81	19.81
Glucose syrup (30-32 DE)	1.93	1.93	1.93
Sodium chloride (food grade)	0.13	0.13	0.13
Carrot juice	--	10	--
Beet juice	--	--	10
Total	100	100	100

DE= Dextrose Equivalent

Table 2: Chemical Composition of Marshmallows Products (kids' candy)

Parameters Treatments	Moisture Content (%)	Total Solids TS (%)	Total Soluble Solids (TSS)(ºBrix)	Ash (%)	Total Sugars (%)	Reducing Sugars (%)
Control Imported Marshmallow	17.06[b]	82.94[a]	55.03[b]	0.16[b]	49.15[b]	32.99[b]
Control 2 Local Marshmallow	20.53[ab]	79.47[ab]	53.81[b]	0.14[b]	51.93[ab]	29.45[b]
Blank Marshmallow	27.06[a]	78.94[ab]	64.07[a]	0.15[b]	49.39[b]	15.28[c]
Red beet Marshmallow	24.35[a]	74.65[b]	57.75[a]	0.29[a]	57.28[a]	44.05[a]
Orange Marshmallow	26.51[a]	73.49[b]	60.93[a]	0.26[a]	42.52[b]	10.03[d]

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$).

Table 3: Main Physical Parameters of Marshmallows Products (kids' candy):

Parameters. Treatments	Color Indexat (420 nm)	Identification Colors Orange (425-485nm) (400-600nm)	Red(500-550nm) (500-600nm)
Imported Marshmallow	0.0783[c]	0.898(445nm)	0,285 (510nm)
Local Marshmallow	0.0754[c]	ND	ND
Blank Marshmallow	0.0207[d]	ND	ND
Red beet Marshmallow	0.2348[a]	ND	0.487 (554nm)
Carrot Marshmallow	0.1465[b]	1.029 (470nm).	ND

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$).

Table 4: Total Antioxidants Activity and vitamins content in Marshmallows Products (kids' candy) on a dry weight basis:

Parameters. Treatments	Antioxidant Activity.(DPPH %)	V.C mg/100gm	%RDI	V.E mg/100gm	%RDI
*RDI.		90		33	
Imported Marshmallow	44.30[c]	0.31[c]	0.34	0.19[c]	0.575
Local Marshmallow	45.15[c]	0.11[d]	0.12	0.33[c]	1.00
Blank Marshmallow	55.43[b]	0.14[e]	0.15	0.25[c]	0.75
Red Marshmallow	63.31[a]	23.00[a]	25.55	1.30[a]	3.94
Carrot Marshmallow	58.85[b]	7.19[b]	7.98	0.56[b]	1.70

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$) * Reference-Daily-Intake, (2020) (RDI)(mg/kg) for Adults & Children≥4years (www.fda.gov/nutritioneducation).

Table 5: Minerals Content ofMarshmallows Products (kids' candy) on a dry weight basis mg/100g

Main Minerals content (mg/kg) Items	Fe	%RDI	Ca	%RDI	Mg	%RDI	Zn	%RDI	Se	%RDI
*RDI.	18		1.300		420		11		55	
Imported Marshmallow	3.57[d]	19.83	279.13[c]	21.46	77.52[c]	18.46	6.85[c]	62.27	0.025[c]	0.05
Local Marshmallow	4.14[d]	23.00	312.90[c]	24.07	101.73[bc]	24.22	9.76[c]	88.73	0.00[c]	0.00
Blank Marshmallow	6.58[c]	36.56	401.05[b]	30.85	90.16[c]	21.47	3.24[c]	29.45	0.044[c]	0.08
Red Marshmallow	39.72[a]	220.67	319.72[c]	24.59	417.01[a]	99.29	29.53[a]	268.45	0.61[b]	1.11
Carrot Marshmallow	15.44[b]	85.78	532.65[a]	40.97	156.07[b]	37.16	18.78[b]	170.73	0.74[a]	1.35

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$) *Reference-Daily-Intake, (2020) (RDI)(mg/kg) for Adults & Children≥4years (www.fda.gov/nutritioneducation).

Table 6: Texture Profile Parameters and Water Activity of Marshmallows Products(kids' candy)

Parameters. Treatments.	Hardness (N)	Adhesiveness (Ns^{-1})	Springiness (mm)	Cohesiveness (~)	Gumminess (N)	Chewiness (N mm)	Water activity (aw).
Imported Marshmallow	1.4[a]	0.282[b]	3.95[a]	0.89[ab]	2.81[a]	4.72[ab]	0.627[b]
Local Marshmallow	1.1[a]	0.214[b]	4.00[a]	0.86[c]	1.40[b]	4.16[b]	0.735[ab]
Blank Marshmallow	1.0[ab]	0.327[ab]	3.20[b]	0.86[c]	1.29[bc]	3.29[c]	0.763[ab]
Red beet Marshmallow	0.6[b]	0.415[a]	4.01[a]	1.05[a]	1.00[c]	3.07[c]	0.827[a]
Carrot Marshmallow	1.5[a]	0.364[a]	3.95[a]	0.91[b]	1.51[b]	5.65[a]	0.792[a]

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$).

Table 7 Reconstitution Ratio (%) of Tasted Marshmallows Products (kids' candy) Products at Ambient Temp., (±25°C):

Rehyd.,/Time (every 1 hr.). Treatments.	1 hr.	2 hr.	3 hr.	4 hr.	5 hr.	6 hr.
Imported Marshmallow	130.27[a]	139.95[a]	140.56[a]	140.54[a]	140.60[a]	149.92[a]
Local Marshmallow	105.75[ab]	83.15[b]	63.10[c]	63.10[c]	42.09[d]	30.19[d]
Blank Marshmallow	89.53[c]	89.53[b]	77.13[b]	77.13[b]	77.13[b]	47.59[c]
Red beet Marshmallow	93.06[c]	68.02[c]	68.02[bc]	54.07[d]	54.07[c]	54.07[bc]
Carrot Marshmallow	100.00[b]	83.37[b]	75.45[b]	75.45[b]	64.86[bc]	64.86[b]

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$).

Table 8: Sensory Evaluation of Different Suggestion Marshmallow Products (kids' candy)

Parameters. Treatments.	Appearance (10)	Color (10)	Flavor (10)	Texture (10)	Taste (10)	Overall Score (50)	Overall Palatability
Imported Marshmallow	9.2[a]	8.2[b]	8.3[ab]	9.4[a]	9.1[a]	44.2[a]	V
Local Marshmallow	8.3[b]	8.8[ab]	8.7.[ab]	9.8[a]	8.0[b]	43.6[b]	G
Blank Marshmallow	8.7[ab]	9.3[a]	8.4[ab]	9.6[a]	8.7[ab]	44.7[a]	V
Red beet Marshmallow	9.4[a]	8.1[b]	8.0[b]	8.9[b]	8.4[b]	42.8[b]	G
Carrot Marshmallow	8.7[ab]	9.2[a]	8.5[ab]	9.2[ab]	8.5[b]	44.1[a]	V

Means followed by different letters in the same column are significantly different by Duncan's multiple tests ($p < 0.05$) Excellent= (10), Very good= (8-9), Palatable = (6-7), and Unpalatable. = (0-5). These proportions were scored on a scale from 1-10.

الخصائص الفيزيائيه والكيميائيه لحلوى الأطفال (المارشيمليو) مع البنجروالجزركلون طبيعي.

إيمان شحاته عبدالمقصودغنيم [1,*]، سماح امين طه ابوالمعاطي [2]،هبه علي يوسف شعت [2]، إيمان محمد حماد [2]

[1]قسم الاغذيةالخاصة والتغذية،معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، جيزة، مصر.

[2]قسم علوم وتكنولوجيا الاغذية، كلية الزراعة بنات، جامعةالازهر، القاهرة، مصر.

* البريد الإلكتروني للباحث الرئيسي:Emanghoname2020@gmail.com

الملخص العربي:

تُعد حلوى المارشميلو واحدة من أقدم أنواع حلويات الأطفال المتداولة. وفي ظل الاتجاه المتزايد نحو استخدام المصادر الطبيعية في تصنيع الأغذية وتجنب الألوان والنكهات الصناعية، يهدف هذا البحث إلى إنتاج حلوى المارشميلو باستخدام مصادر طبيعية للألوان والنكهات مثل البنجرالأحمر والجزر.تُظهر النتائج أن استخدام عصائر البنجر الأحمر والجزر يُحسّن من القيمة الغذائية والخصائص الفيزيائية واللونية ومحتوى المعادن والنشاط المضاد للأكسدة لحلوى المارشيمليو، مع الحفاظ على تقبل المستهلك.أظهر مارشيميلو الجزر أعلى محتوى من الكالسيوم والسيلينيوم (532.65 و0.74 ملجم/كجم)، بينما احتوى مارشيميلو البنجر الأحمر على مستويات أعلى من الحديد والماغنيسيوم والزنك مقارنة بالعينات الأخرى وسجلت عينات حلوى المارشميلو بالبنجر الأحمر أعلى نشاط مضاد للأكسدة بنسبة 63.31%، مقارنة بأقل نشاط مضاد للأكسدة في العينة المستوردة بنسبة 44.30% . ولكنها تفوقت في محتوى فيتامين C بنسبة 23 ملجم وفيتامين E بنسبة 1.30 ملجم مقارنة بالعينات الأخرى. كما أظهرت نتائج التقييم الحسي عدم وجود فروق كبيرة في النكهة والقوام بين العينات، باستثناء المارشميلو المصنوعة من عصير البنجر الأحمر، التي حصلت على تقييم أقل من حيث النكهه. يبرهن هذا البحث على أن إنتاج المارشميلو باستخدام عصائر طبيعية هو خيار اقتصادي ويوفر بديلًا صحيًا للألوان الغذائية الاصطناعية.

الكلمات الاسترشادية:حلوى المارشميلو، ألوان ونكهات طبيعية، بنجر أحمر، جزر، مضادات أكسدة طبيعية.