

Investigation of the effect of sucrose substitution with Stevia on the structure, physicochemical and sensory properties of ice cream

خه نده سىروان ستار الداودى¹

¹ بهشى زانستى خوړاك، كوښى نهندازى كشتوكاڼ، زانكوى ئىسلامى نازادى، شارى سنه، ئىران

Corresponding author's e-mail: Khandasirwan.1994@gmail.com

Abstract:

Consumption of milk and its products is considered as one of the indicators of human societies' development. Ice cream as one of the most popular milk products around the world has many fans but due to its high amount of sucrose has negative effects on health. Stevia, a natural sweetener, was used as a sucrose substitute at 0-100% replacement levels in ice cream formulation. To investigate the treatments produced, physicochemical properties in ice cream including specific gravity, viscosity, melting time of the first drop, melting amount, overrun. The results showed that viscosity decreased by 100% by increasing the amount of stevia replacement. While overrun, Firmness, melting time of the first drop and consequently the melting stability of the samples increased with increasing the percentage of stevia used, Sensory test results showed that there was no significant difference between stevia and control samples except cold sensation and ice crystal. As a general result, stevia sweetener is a suitable substitute for sugar and samples containing 100-75% stevia were identified as desirable treatment.

Keywords: Stevia, ice cream, structure, physicochemical properties, sensory properties

گوفارى زانكوى هه له بجه: گوفارىكى زانستى ته كادىميه زانكوى هه له بجه ده رى ده كات	
به رگ	7 ژماره 2 سالى (2022)
رېككه وته كان	رېككه ونى وه رگرتن: 2021/7/11 رېككه ونى په سه ندردن: 2022/4/2 رېككه ونى بلاو كرده وه: 2022/6/30
نېمه يلى تويزه	Khandasirwan.1994@gmail.com
ماڤى چاپ و بلاو كرده وه	© 2022 خه نده سىروان ستار الداودى، گه پشتن بهم تويزينه وه په كراوه په له ژير په زامه ندى CCBY-NC_ND 4.0

ويعتبر استهلاك الحليب ومنتجاته أحد مؤشرات تنمية المجتمعات البشرية. الآيس كريم باعتبارها واحدة من منتجات الحليب الأكثر شعبية في جميع أنحاء العالم لديها العديد من المشجعين ولكن نظرا لكمية عالية من السكر له آثار سلبية على الصحة. ستيفيا، التحلية الطبيعية، واستخدمت كبديل السكر في مستويات استبدال ١٠٠٪ في صياغة الآيس كريم. للتحقيق في العلاجات المنتجة، خصائص الفيزيائية الكيميائية في الآيس كريم بما في ذلك الجاذبية المحددة، اللزوجة، وقت ذوبان أول قطرة، كمية ذوبان، تجاوز. وأظهرت النتائج أن اللزوجة انخفضت بنسبة ١٠٪ عن طريق زيادة كمية استبدال ستيفيا. في حين تجاوز، الحزم، وقت ذوبان أول قطرة، وبالتالي زيادة استقرار ذوبان العينات مع زيادة النسبة المئوية للستيفيا المستخدمة، وأظهرت نتائج الاختبار الحسي أنه لا يوجد فرق كبير بين ستيفيا وعينات التحكم باستثناء الإحساس البارد والكريستال الجليد. ونتيجة لذلك، تحلية ستيفيا هو بديل مناسب للسكر وعينات تحتوي على ٧٥-١٠٠٪ ستيفيا تم تحديدها كعلاج مرغوب فيه.

الكلمات المفتاحية: ستيفيا، الآيس كريم، التركيب، خصائص الفيزيائية الكيميائية، والخصائص الحسية

پوخته:

خواردن و خواردنهوهی شیرو بهرهمه کانی وههروههه به کارهینانیان له بییشه سازی خوراکدا ئامازنه ئامازنه بۆ پێشکهوتنی کۆمه لگای مرۆفایه تی. ئایس کریم یه کێکه له بهرهمه به ناوبانگه کانی شیرمه تی له جیهاندا وه زماریه کی زۆر مرۆف ئاره زووی خواردنی ده کات به لام به هووی هه بوونی ریژه یه کی زۆر سوکه روژ تیايدا کاریکه ری لاوه کی هه یه له سه ر ته ندروستی. له م توینینه وهیه دا ستیفیا به کارهینرا وه کو شیرین کهریکی سروشتی له شوینی سوکه روژ به ریژه ی ١٠٠٪ له دروستکردن پیکهاته ی ئایس کریم له م توینینه وهیه دا بشکین و لیکۆلینه وه مان کرد له سیفته فیزیای و کیمیاییه کان (قورسای جۆری، لینی، پله ی توانه وه ی یه که م دلۆپ وه ریژه ی توانه وه)، له ئه نجامه کاندانه وه مان بۆ ده رکه وت که لینی که م بوویه وه به ریژه ی ١٠٠٪ به به رزکردنه وه ی ریژه ی ستیفیا وه له هه مان کاتدا تیپه ر بوون و جیگهری پله ی توانه وه ی یه که م دلۆپ زیاتر بوو ئه مه ش وا ده کات توانه وه ی نمونه کان جیگهر تر بێت به زیاد کردنی ریژه ی ستیفیا به کارهاتوو، ئه نجامی گشتی ئه وه یه که شیرین کهری ستیفیا جیگهره وه یه کی باشی شه کره وه ئه و نمونانه ی که ٧٥-١٠٠٪ ستیفیا تیایه به وه ده ناسرین که چاره سه ری په سه ندکراون

وشه کللیه کان: ستیفیا، ئایس کریم، سیفته فیزیای و کیمیایی وه سه ته وه ریبه کان

Introduction:

Humans are born with an innate preference for sweet taste (Behrens et al., 2011). Increasing consumers' knowledge and awareness about the role of nutrition on the health of the individual has led producers to produce products containing fat, sugar and low salt and more fiber (Lisak, et al., 2011). in which the amount of sugar intake and calories produced in the human body are reduced and these products for obese people These low-calorie foods have been popularized in different societies in order to reduce energy intake, control body weight and diseases such as diabetes, (Nabors et al., 2003). Various compounds have been investigated and used to replace commercial sugar (Louis et al, 2007). Many parents' desire reduced-sugar products for their children and current studies emphasize the importance of developing healthy eating habits at a young age (Chan et al., 2011; Byrd-Bredbenner et al., 2016).

Ice cream is a physicochemical system in which ice crystals, air bubbles and fat cells are distributed in a con-

tinuous phase containing sucrose, polysaccharides and milk proteins. Ice cream typically contains 10 to 16 percent fat and 15 percent sucrose (Maki et al., 2002; McGhee et al., 2015). Ice cream with this amount of sugar is often sweet and thereby it causes weight gain and ultimately complications of obesity. Considering the popularity of ice cream among different people and the wide range of consumption of low-calorie ice cream production, it can play an important role in reducing the mentioned problems. It should be noted that sucrose determines the amount of ice and Firmness of ice cream by adjusting the amount of solids, creating sweetness and producing calories. (Farahnoudi, 1998). By reducing or removing sucrose, serious damage to the tissue, rheological properties and taste of the product is done, which should be a good alternative to solve these problems.

There are many efforts to use natural products in food. One of these products that have been considered most is a plant called *Stevia Rebaudiana*, also known as "honey leaf" plant. *Stevia* lacks calories and the absence of glucose, fructose, sucrose and maltose has been proven (Pon et al., 2015). This plant has sweet leaves, which is a source of a few sweet-flavored glycosides known as steviol glycosides (Safdarzadeh and Askar, 2013). Four major stevia glycoside types have been identified: ribadiosid A, stenoside, ribadiosid C and alcoside A. Ribadioside A with the power of 150 to 300 times more sugar has the best quality of sweetness among other types. (Yadav et al., 2011) About 14 percent of the constituents of stevia's dried leaves make up these sweetener compounds. (Leung et al., 1996). These sweeteners can be used in a variety of food products, including sauces, soft drinks, compote, gum, ice cream, toothpaste and mouthwash. JECFA (Committee on Food Additives Joint FAO/WHO Expert) has authorized daily absorption of 2 mg/kg body weight and the FDA has authorized its use as a dietary supplement (Kroger et al., 2006; Wallin, 2004). The human body does not have the ability to consume glycosides found in stevia leaves. So it excretes them without producing calories. This class of sweeteners, unlike alcoholic sugars, is stable at high temperatures and does not lose its sweetening properties (Kroyer, 2010) and is stable against temperatures above 100°C and stable at pH 3–9, does not ferment and does not change as a result of cooking. (Yadav, 2011).

Since stevia plant is considered as a high sweetener and therapeutic property economically and scientifically, in this study *Stevia* was used on different surfaces to produce ice cream. The aim of producing ice cream with the desired taste and appearance was to contain stevia sweetener that can be marketed.

Materials and methods:

Material:

To do this research Sterilized and homogenized milk (with 1.5% fat) and sterilized and homogenized cream (with 30% fat), infant formula (0.01% fat), stevia with 97% purity, carboxy methyl cellulose, sucrose and vanilla were used.

Methods:

Ice cream preparation method:

Weighing the raw materials, the milk was heated to 40-45 °C. In the next step, the milk and cream were uniform with manual stirrer for 1 minute. Stevia sucrose and formula were added to the liquid material and mixed with mechanical stirrer at 70rpm for 5 minutes and finally cooled to 5°C using cryogenic substance (ice and brine) and then the delivery process was done at 4-6°C in the refrigerator for 24 hours. Vanilla was added to the mixture in a non-continuing ice cream maker and finally soft ice cream was placed in a lidded plastic container made of polyethylene in -18 freezing. Ice cream prepared to perform tests was kept at this temperature (Akalin and Erisir, 2008).

Methods and Tests:

Specific gravity:

This method was performed on ice cream mixture and after delivery by picnometry method at 25°C, so that dry and empty pycnometer weight (G), pycnometer weight with distilled water (G1) and pycnometer weight plus sample (G2) were measured and the specific weight was calculated by the following formula (Goff and Hartel, 2013)

$$\text{Specific gravity} = (G_2 - G) / (G_1 - G)$$

Viscosity:

The viscosity of the ice cream mixture was carried out by Brookfield rotary viscosity (Made in USA, ProDV- at 5°C for 20 seconds on an ice cream mixture with a volume of 600 mg with spindle no. 64 and a speed of 50 rpm (Livney and Hartel, 1996 ; Amiri and Ahmadi, 2013).

Melting time of the first drop:

An ice cream sample containing stevia at 30 g at 25°C was placed on a lattice metal plate in the mouth of Erlenmeyer inside the incubator and the time of the first melted drop was noted. (Marshall and Arbuckle, 1996).

Melting amount:

Thirty grams of ice cream samples were placed on a metal plate in Erlenmeyer crater inside the incubator at 25°C and the weight of melted ice cream was measured in percentage of the sample after 40 minutes (Marshall and Arbuckle, 1996; Pon, 2015).

Overrun:

Weighted volume increase by comparing a certain volume of ice cream mixture before freezing (m1) and after freezing (m2) and calculating their difference percentage through the following relationship was obtained (Marshall and Arbuckle, 1996):

$$100 \times (m2 / (m2 - m1)) = \text{overrun (\%)}$$

To obtain firmness of samples with a diameter of 50 mm and height of 26±1 after the tightening phase, tissue analysis with 5 mm cylindrical probe, penetration rate of 1 mm/s and penetration rate of 10 mm were used (Soukoulis et al, 2010).

Sensory test:

Sensory evaluation of samples was performed after 1 day of storage at -18 and 5-point hedonic test by 15 panelists (6 males and 9 females). In this test, the characteristics of color, taste, coldness, non-oral tissue, oral lining, firmness, crystalline intensity, Intensity of coldness in the mouth and overall acceptance were evaluated (Hettiarachchi, and Illeperuma, 2015).

Statistical analysis:

In order to investigate stevia, dependent variables (viscosity, overrun, Firmness, time of first drop melting, specific gravity) of the block design were performed in three replications. The three levels used by Stevia: sugar included 0:100, 25:75, 50:50, 75:25, 100:0. The results were analyzed using SAS 9.1 software.

Results and Discussion:**Specific gravity:**

Specific gravity of samples containing stevia changed from 1.06 to 1.14 (Table 1). according to stevia substitution with sucrose, and showed that by increasing the amount of stevia substitution up to 100% of the specific gravity of the samples, the reduction can be described as such, because the total dry matter content decreased by 0% due to the reduction of sucrose content. These results were similar to the results that Giri et al. did in 2012. They used stevia at three levels of 50, 60 and 70 percent as a sucrose substitute in Kulfi ice cream, which was found to decrease with increasing stevia substitution level (Giri et al., 2012).

Viscosity:

Viscosity or flow resistance, which in addition to helping to determine the most suitable formulation in choosing the right pump for transferring and designing the required equipment (Marshall and Arbuckle, 1996). This feature also has a significant impact on the sensory quality and structure of ice cream (Aime et al., 2001). The results decreased with increasing the percentage of stevia replaced with sucrose viscosity of the ice cream mixture so that the lowest viscosity was observed in the complete replacement of stevia. Viscosity of ice cream samples changed from 855 to 1867 centipede (Table 1). Stevia is a plant that is 150 to 300 times sweeter than sucrose, which is why a smaller amount is used in the formulation of produced ice cream, thus reducing the amount of dry matter and ultimately reducing the viscosity of ice cream, while sucrose is mixed with the liquid part by hydroxyl agents in its structure, along with carboxy methyl cellulose gum due to intense hydrophilicity. This increases the viscosity of the ice cream mixture, which eventually produces a very concentrated solution. (Goff and Hartel, 2013; Meyer et al., 2011; Alizadeh et al., 2014). According to these findings, Gogbasiberg et al. (2011) and Alizadeh et al. (2014) also reported that by increasing sucrose replacement with stevia viscosity decreased in low-fat yogurt and ice cream (Guggisberg et al., 2011; Alizadeh et al., 2014).

Treatments	Stevia (%)	Specific Gravity	Viscosity(mPa.s)
control	0	1.16	1867.48±46.28
1	25	1.11	1789.47±35.79
2	50	1.10	1373±64.60
3	75	1.07	927.18±53.14
4	100	1.06	855.68±48.7

Table 1: Effect of stevia on Specific Gravity and Viscosity in ice cream

Melting time of the first drop:

The melting time of the first drop changed from 5 to 25min in different treatments, which indicates the significant effect of stevia (Table 2). With increasing the amount of stevia in ice cream samples, the melting time of the first drop increased so that the lowest melting time of the first drop was related to the samples containing 0% stevia and the highest melting time of the first drop was related to the samples containing 100%. The two factors of heat transfer and mass transfer cause the melting of ice cream so that the ambient barrier gradually penetrates into the ice cream from the outer part and causes the melting of ice cream (Amiri Ogadaie et al., 2010). As a result of this increase, the growth rate of ice crystals also increases and ice crystals grow and in ice cream tissue increases the Firmness and it can be said that the firmness of the tissue is directly related to the melting time of the first drop.

Melting amount:

The melting amount of ice cream is influenced by factors such as inlet air, formation of fat cells during freezing, shape and growth of ice crystals, fat instability and firmness of ice cream tissue (Muse and Hartel, 2004). The heat of the environment melts the ice crystals. The water from the melting of the ice crystals is dispersed in the non-frozen serum phase, and then the diluted liquid passes through the foam-like structure of ice cream and finally flows (Amiri Ogadaie et al., 2010). By increasing the amount of sucrose replacement with stevia, we saw a decrease in the melting amount of ice cream, which is due to the decrease in the amount of dry matter by reducing the amount of sucrose consumed, on the other hand, it can be stated that the reduction of dry matter increases in ice cream. And the higher the volume, the slowly the heat penetrates into the ice cream due to the insulating role of the air and the amount of melting decreases (Table 2). Giri et al (2012) also reported the effect of stevia on Kulfi ice cream that samples with higher amounts of stevia had lower melting than the control sample, citing increased moisture content and ice crystal size due to a decrease in sucrose (Giri et al., 2011). Pon et al. (2015) also announced that stevia ice cream as a sucrose substitute decreased due to the increase in overrun and the reduction of heat transfer of ice cream melting amounts (Pon et al., 2015).

Treatments	Stevia (%)	First dropping time (min)	Melting rate(%)
control	0	5	95
1	25	10	70
2	50	17	55
3	75	21	40
4	100	25	35

Table 2: Effect of stevia on First dropping time and Melting rate in ice cream

Overrun:

Overrun affects the stability, texture firmness and sensory properties of ice cream. This feature also reduces the growth of ice crystals during freezing, reduces the amount of melting, and increases the stability of the foam during storage (Goff and Hartel, 2013). Overrun was a variable of different treatments, which according to the results increased the volume of ice cream samples by increasing the amount of stevia used (table 3). The reason for this can be attributed to the decrease in the amount of viscosity (Amiri and Ahmadi, 2013). As the amount of sucrose decreases, the viscosity also decreases. With this decrease in viscosity, the stirring and mixing operations are accelerated and the gel structure and clusters of fat cells are torn and disintegrated, which eventually causes the air to mix with the mixture and overrun increase (Marshall and Arbuckle, 1996). However, it should be noted that replacing 100% sucrose with stevia was less than 75% because excessive reduction of dry matter and replacement of water in the freezing phase reduced overrun to 0% sucrose, which is based on the findings of Pon et al. (2015) were consistent (Pon et al., 2015).

Firmness:

As shown in Table 3, samples containing 100% stevia had the highest Firmness. Samples containing 0% stevia had the lowest Firmness (0.98 N). The Firmness of ice cream texture is defined as its resistance to deformation by external forces and by factors such as overrun, ice crystal size and volume. The ice phase is affected. Increased tissue Firmness is due to a decrease in the amount of sucrose in the ice cream formulation, which replaces the sucrose water in the mixture, and during freezing the volume of the ice phase increases due to a drop in freezing point temperature. Sucrose also prevents the transfer of water molecules to the surface of ice crystals by increasing the viscosity of the ice cream mixture and by restricting mass transfer, and slows the growth of ice crystals. Freezing increases and tissue Firmness increases (Guggisberg et al., 2011). A similar result was observed in a study by Giri et al. (2012) (Giri et al., 2011).

Treatments	Stevia (%)	Overrun (%)	Firmness(N)
control	0	30.00±1.2	0.98±0.16
1	25	36.01±1.41	1.58±0.64
2	50	45.00±0.37	3.01±0.27
3	75	61.00±1.00	4.95±0.18
4	100	58.00±0.54	7.68±0.44

Table 3: Effect of stevia on Overrun and Firmness in ice cream

Sensory evaluation:

After reviewing the results obtained by the panelists, it can be said that there was no significant difference between the samples containing stevia and the control sample except for crystalline intensity and coldness. Due to the replacement of stevia with sucrose and reduction of dry matter and increase of water and ice phase volume, more ice crystals were formed and were felt in the mouth when eating. Since sucrose reduces the feeling of cold in the mouth, we saw that with decreasing sucrose, the intensity of cold intensified, so the samples containing stevia scored lower than the control sample.

Conclusion:

The results showed that with increasing percentages of natural stevia used instead of sucrose, viscosity and melting rate decreased, overrun, melting time of the first drop and Firmness increased. In terms of sensory evaluation, we concluded that the overall acceptance of regular ice cream and diet ice cream were not significantly different, but diet ice cream containing stevia scored lower in terms of crystalline intensity and coldness. With the obtained results, it can be mentioned that stevia sweetener is a suitable substitute for sugar and it is possible to achieve products with lower risk for consumers' health, which are combined with desirable physicochemical, rheological and sensory properties.

Reference:

1. Alizadeh, M., Azizi-Lalabadi, M., Kheirouri, S. (2014). Impact of using stevia on physicochemical, sensory, rheology and glycemic index of soft ice cream. *Food and Nutrition Sciences*, Vol:5.pp: 390-396.
2. Amiri, Z. R., Ahmadi, M. E. (2013). The possibility of substitution of carboxy methyl cellulose and tragacanth gum on the physical and sensory properties of ice cream. *Journal of Food Research*. Nol:24 (2).pp: 279-290. [In Persian].
3. Amiri Ogadaie, S., Alami, M., Rezaie, R., Dadpour, M., Khomeiri, M. (2010). Effect of Basil seeds and Psyllium mucilage on the physiological, rheological and sensory properties of soft ice cream. *Journal of Food Science and Technology Research and Innovation*. Vol: 1 (1).pp: 23-36. [In Persian].
4. Aime, D., Arntfield, S., Malcolmson, L., Ryland, D. (2001). Textural Analysis of reduced vanilla ice cream products. *Food Research International*, Vol; 34.pp: 237-246.
5. Akalin, A., Erisir, D. (2008). Effects of Inulin and Oligofructose on the Rheological Characteristics and Probiotic Culture Survival in Low-Fat Probiotic Ice Cream. *Food Microbiology and Safety*, Vol; 4. pp: 184-188.
6. Behrens, M., W. Meyerhof, C. Hellfritsch, and T. Hofmann. (2011). Sweet and umami taste: Natural products, their chemosensory targets, and beyond. *Angew. Chem. Int. Ed. Engl.* 50:2220–2242. <https://doi.org/10.1002/anie.201002094>.
7. Byrd-Bredbenner, C., J. McKinley, J. Martin-Biggers, and E. Gager. 2016. Encouraging reductions in sugar-sweetened beverage consumption: HomeStyles Best Drinks for Families guide. *J. Nutr. Educ. Behav.* 48:S11–S12. <https://doi.org/10.1016/j.jneb.2016.04.035>.
8. Chan, K., G. Prendergast, A. Gronhoj, and T. Bech-Larsen. 2011. Danish and Chinese adolescents' perceptions of healthy eating and attitudes toward regulatory measures. *Young Consumers* 12:216–228. <https://doi.org/10.1108/17473611111163278>.
9. Farahnoudi, F. (1998). *Dairy Processing Handbook*. Tehran. Publications Research and Education Tehran Jahad , pp:323-328. [In persian].
8. Giri, A., Rao, H., and Ramesh, V. (2012) .Effect of partial replacement of sugar with stevia on the quality of kulfi. *Food Science Technology*, vol:51 (8). pp: 1612-1616.
10. Guggisberg, D., Piccinali, P., Schreier, K. (2011). Effects of sugar substitution with Stevia, Actilight_ and Stevia combinations or Palatinose_ on rheological and sensory characteristics of low-fat and whole milk set yoghurt. *International Dairy Journal*, 21: 636-644.
11. Goff, H., Hartel, R. (2013). *Ice cream*. 7th. Springer New York Heidelberg Dordrecht London, 403-430.
12. Hettiarachchi, C. A., Illeperuma, D. C. K. (2015). Developing a trained sensory panel for comparison of different brands of vanilla ice cream using descriptive sensory analysis. *Journal. Natn. Science .Foundation Sri Lanka* .vol; 43(1). pp: 45-55.
13. Kroger M, Meister K, Kava R. (2006) Low-calorie sweeteners and other sugar: A review of the safety issues, *An Academic And Scientific Journal Issued By University Of Halabja*

Compr Rev Food Sci Food Safe; vol:5. pp: 35-47.

14. Kroyer G. (2010). Stevioside and Stevia-sweetener in food: application, stability and interaction with food ingredients. J Consumer Protec Food Safe; vol 5. pp:225-229.

15. Leung AY, Foster S. (1996). Encyclopedia of common natural ingredients used in food, drugs and cosmetics. New York: John Wiley and Sons 1996.

16. Lisak, k.Jelcic, I. Tratnik, L. Bzanic,R. (2011). Influence of sweetener stevia on the quality of strawberry flavoured fresh yoghurt. Quality of flavoured fresh yoghurt. Mljekarstvo. vol: 61 (3). pp:220-225.

17. Livesey G. (2001). Tolerance of low-digestible carbohydrates:a general view. Brit J Nutr. 2001; 85 suppl vol: 1.pp: 7-16.

18. Louis, J.L.Balestrieri, M.L and Napoli, C. (2007). Nutrition, physical activity and cardiovascular disease. Cardiovascular Research vol:73. pp: 326-340.

19. Pon, S. Y., Lee, W. J., Chong, G. H. (2015). Textural and rheological properties of stevia ice cream. International Food Research Journal. Vol:22 (4). pp: 1544-1549.

20. Safdarzadeh, M., Askar, M. (2012). Steviahealthy Society-healthy life,Second National Conference on FoodScience and Technology.Guchan. Iran. [In persian].

21. Soukoulis, C., Rontogianni, E., Tzia,C.(2010). Contribution of thermal, rheological and stability of yog-ice cream with added inulin. International Journal of Dairy Technology,vol: 55. pp: 89-93.

20. Marshall, R.T., Arbuckle, W.S. 1996. The science of Ice cream. 5thed. Torkashvand, Y. Eta. Tehran. [In Persian].

22. Muse, M., Hartel, R. (2004). Ice crem structural elements that affect melting rate and hardness.Journal of Dairy Science, vol 87. pp: 1-100.

23. Maki, K., Davidson, M., Tsushima, R.,Matsuo, N., Tokimitsu, I., Umpororowicz, D., Dickeli, M., Foster, G., Ingram, K., Anderson, B., Frost, S., Bell, M. (2002).Consumption of diacylglycerol oil as part of a reduced-energy diet enhances loss of body weight and fat in comparison with consumption of a triacylglycerol control oil.American Society for Clinical Nutrition, vol; 76. pp: 1230-1236.

24. McGhee, Ch. E., Jones, J. O., Park, Y. W. (2015), Evaluation of textural and sensory characteristics of three types of low-fat goat milk ice cream. Small Ruminant Research, 123 pp: 293-300.

25. Nabors, L., Lehmkuhl, H., Christos, N., & Andreone, T.L. (2003). Children with Diabetes: Perceptions of Supportsfor Self-Management at School. Journal of school health, vol 73(6). pp: 216-221.

26. Wallin H. (2004). Steviol Glycosides: Chemical and technical assessment. FAO, 63rd JECFA.Geneva; 3-4.

27. Yadav, A.K., Singh, S., Dhyani, D., & Ahuja, P.S. (2011). A review on the improvement of stevia [Stevia rebaudiana (Bertoni)]. Canadian Journal of Plant Science, vol 91(1). pp:1-27.