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Development and quality evaluation of the handmade chocolate using stevia and starch

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Abstract

Preparation of stevia chocolate is an innovative, futuristic research in the field of functional food preparation which may enhance the medicinal value without an adverse effect to the human health. During the research, chocolate were prepared with natural sweetener stevia and its effect were investigated. The chocolate is prepared using cocoa powder, milk powder, stevia, unsalted butter, cocoa butter, cranberries and agar-agar. Two samples were made by addition of starch as a bulking agent. For flavor enhancement cranberry was chosen for the all sample preparation. On the basis of obtained results i.e.; sensory, physical and nutritional properties, sample 1 having cocoa butter 15 ml, unsalted butter 35 ml, cocoa powder 25 gm, stevia 25 gm, starch 25 gm, milk powder 25 gm, cranberry 2gm, agar- agar 5 ml and sample 2 having cocoa butter 15 ml, unsalted butter 40 ml, cocoa powder 25 gm, starch 50 gm, stevia 30 gm, milk powder 25 gm, cranberry 2gm, agar-agar 2 ml. The sensory analysis is done on the basis of 9-point hedonic scale. The overall acceptability score of sample 1 is 8 & sample 2 is 7 out of 9 points. The nutritive value of sample 1 chocolate were fat 13.08%, protein 13.47%, sugar 14.22, moisture content 9.93%, ash 3.48%, starch 11.47%. All the quality value of developed samples is noted. It was noted that the sensory, physical and nutritive qualities were improved due to incorporation of acceptable level of stevia at certain proportion. Stevia chocolate showed good quality characteristics on all the considered parameters. Results obtained were satisfactory & the developed chocolate is acceptable. Thus health benefits in the form of sugar free chocolate can tickle the taste buds of the consumers & influence them for consuming it for a healthy well-being. Hence, development & utilization of such functional foods will not only improve the nutritional status of the population but also helps those suffering from many diseases.

Keywords: Dark chocolate, natural sweetener, stevia, sugar free, starch, cocoa powder

Introduction

Chocolate is a sweet & brown food, preparation of roasted and ground cacao seeds that is made in the form of a liquid, paste, or in a block, or used as a flavoring ingredient in other foods. The earliest evidence of use traces to the Olmecs which is present Mexico, with evidence of chocolate beverages dating to 1900 BC. The majority of Mesoamerican people made chocolate beverages, including the Maya and Aztecs. The word "chocolate" is derived from the Classical Nahuatl word *chocolātl*.

Chocolate is usually consumed in pleasant situations; many people find it delicious because chocolate has a characteristic texture, dissolves in the mouth, and has a nice aroma and a slightly bittersweet taste. Dark chocolate has been noticed that it significantly associated with better physical health. Specifically, chocolate has been suggested to have short-term benefits on reducing blood pressure and serum cholesterol, and on improving insulin sensitivity. Chocolate consumption has been linked to lower incidence of cardiovascular disease. Chocolate is prepared from the seed of a specific plant that is the *obroma cocoa*. It contains many active ingredients. Caffeine is the most important ingredient in chocolate which is a central nervous system stimulant (CNS). Chocolate is also aphrodisiac in nature. Dark chocolate contains various potential anti-oxidants and various essential nutrients which helps and individual to stay fit and healthy. Powerful antioxidants like flavonoids help to avoid cardiovascular disorders and reduce risks of strokes. In addition it works to keep the blood cholesterol level and blood pressure in check of an individual. Roughly two-thirds of the world's cocoa is produced in Western Africa, with Ivory Coast being the largest source, producing a total crop of 1,448,992 tones. The other west countries among the top five cocoa producing countries in the world are Ghana, Nigeria, and Cameroon. Pure, unsweetened chocolate, often called "baking chocolate", contains primarily cocoa solids and cocoa butter in varying proportions.

A large amount of chocolate which are consumed today are in the form of sweet chocolate which are formed by the combination of chocolate with sugar white chocolate has also the same textural property as compared to the milk and dark chocolate but it does not contain any cocoa solid due to this many countries does not accept white chocolate as a chocolate at all the production of dark chocolate is performed by adding fat and sugar to the cocoa mixer unsweetened chocolate is a very pure chocolate liquor which is also known as beta or baking chocolate as it is an unadulterated chocolate therefore the pure, ground, Roasted chocolate beans impart a strong and deep chocolate flavor.

Stevia

Stevia which is a natural sweetening agent extracted from the leaves of *Stevia rebaudiana*. Steviol glycosides, is the compounds which is responsible for sweet taste, have a level of about 200 to 300 times sweeter than simple table sugar, consisting no carbohydrates, calories, or artificial ingredients. Steviol glycosides can have a bitter minty aftertaste when it is consumed in its purest form. It can be used in cooking, particularly where the paramount of stevia is to add sweetness. Stevia does not caramelize and would not perform so well as a direct substitute for sugar in recipes where sugar is an essential part of the structure or texture. Stevioside is a non-carbohydrate glycoside compound. Thereby, it lacks the properties that sucrose and other carbohydrates retain. Besides, being a near-zero calorie food substitute, extracts of stevia have several distinctive properties such as long shelf life, high-temperature tolerance, non-fermentative. Certain glycosides in stevia extract have been found to expand blood vessels, increase sodium excretion, and urine output. The fresh ground stevia is still green as no additional processing besides mechanical grinding has been done. Milled stevia that undergoes water extraction processing and possibly other fillers to give it a "powdery" texture. Fresh leaves can also be cooked and eaten as vegetable. Leaves traditionally used by indigenous South American tribes for hundreds of years to sweeten bitter medicinal drinks and tea.

Starch

Starch is used as a bulking agent and is more complex molecules of starch that have to be broken down first before so that the digestion is easier. These complex carbohydrates are broken down into simple sugars which can then be easily swallowed and passed into the stomach.

Cranberry

Cranberries are a group of dwarf shrub which is evergreen in nature or trailing vines in the subgenus *Vaccinium* of the genus *Oxycoccus*. Adding cranberries to buttery chocolate makes the chocolate more substantial.

Health benefits of chocolate

Chocolate is beneficial for heart health. It protects from disease causing free radicals. The most important benefit of the chocolate is that improves blood flow with lower blood pressure and improves the brain function. Above all aspects considered under mind decided to develop sugar free chocolate using stevia as sweetener and study the physical, chemical and sensory characteristics of developed stevia chocolate.

Materials and Methods

Raw materials

The raw materials were bought from local market and online market depends upon the availability. Required raw material is as follows:

Cocoa Powder, Milk Powder, Cocoa Butter, Unsalted Butter, Stevia, Cranberries, Agar-Agar stabilizer, Starch, Skimmed milk powder

Equipment Used

Soxhlet extractor, Weighing machine, Digital vernier caliper, Furnace, Desiccator, Condenser, heater, glass ware.

Table 1: Chemical used with quantity

Sr. No.	Chemicals	Quantity
1.	Copper sulphate (CuSO ₄)	1.0069gm
2.	Potassium sulphate (K ₂ SO ₄)	10gm
3.	Sulphuric acid (H ₂ SO ₄ 98% concentration)	25 ml
4.	Petroleum ether (C ₆ H ₁₂ bp 30°-60°C)	Distilled in glass
5.	Hydrochloric acid (HCL 36% concentration)	12.5 ml
6.	Methyl red indicator	5-6 drops
7.	Methyl blue indicator	5-6 drops
8.	White spirit	10 ml
9.	Sulphuric acid (H ₂ SO ₄ N/5 dissolved in 1 liter)	50 ml
10.	Caustic soda (50% solid)	100 ml
11.	Folin A, Folin B indicator	5 ml

Chocolate making process

Chocolate was prepared using Cocoa butter, Unsalted butter which were heated at a temperature of 40° C in a double boiling setup. After the heating up of butter the sieved powder of Cocoa powder, Milk powder, Stevia, were added and that was continuously stirred and mixed till the added ingredients were blended together to form a brown smooth paste. The formed paste for cooled down and small amount of agar – agar was added and stirred, a small amount of cranberries were added to enhance the flavor of the chocolate. The chocolate is cooled down to room temperature and further molded into ice tray for stability and the chocolate is cooled in refrigerator. The flow chart for the preparation of handmade chocolate is given in fig 1.

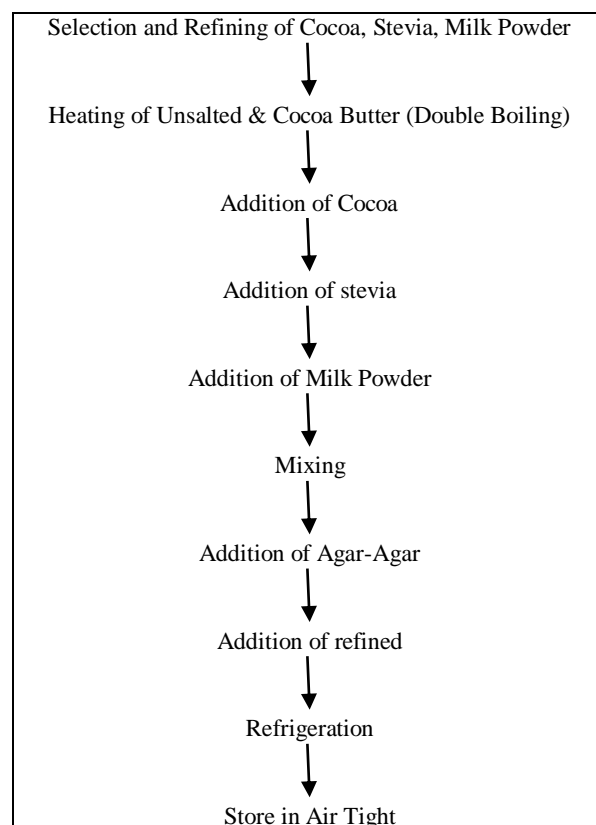


Fig 1: Flow chart for development of handmade chocolate

Weighing and Refining of ingredients

All the ingredients was weighed by the help of weighing balance as per the formula, taking extra care of minor ingredients like butter, agar-agar and cranberries.

Heating of Unsalted & Cocoa Butter (Double Boiling System)

Unsalted butter and cocoa butter is heated at a temperature of 40 °C in a double boiling system before mixing the other ingredients.

Addition of cocoa powder

The cocoa powder is sieved finely with the using muslin cloth and added firstly to the heated butter as this enhances the flavor of chocolate.

Addition of stevia powder

The next step involves addition of finely sieved stevia powder to the mixture which adds the sweetening flavor to chocolate.

Addition of milk powder

Lastly finely sieved stevia powder is added to the mixture, milk powder is added lastly to prevent the coagulation of milk with butter and this gives a smooth texture and light color to chocolate.

Mixing

The major objective of chocolate mixing process was the blend it to further refine and bring the particle size of the added milk powder and stevia particles down to the desired fineness. The Cocoa powder or 'mass' is blended back with the butter and liquor in varying quantities to make different types of *chocolates*.

Addition of agar-agar

Stabilization of the chocolate, a small amount of agar-agar or Chinese grass is added to provide stability. The addition of agar-agar helps in slowing down the melting of chocolate at room temperature.

Addition of starch

Starch (optional) was added as a bulking agent and more complex molecules that have to be broken down first before they can be digested. These complex carbohydrates are broken down into simple sugars which can then be swallowed and passed into the stomach.

Addition of cranberries

Cranberries had that sharper tartness mixed with the rich chocolate, the dried cranberries were a bit sweeter and added some chew, and the chocolate covered cranberries added more texture to the chocolate.

Conching of chocolate by hand

The process called "conching" reduces the moistness of the cocoa mass and removes volatile acids. At the same time, this step allows for specific aromas and smoothness to be associated with chocolate. Conching is the process where the chocolate is "plowed" back and forth through liquid chocolate which smoothes the chocolate and rounds out the flavor, essential for the flavor, the texture and the overall quality of the chocolate.

Tempering of chocolate: Chocolate is tempered it has a shiny, even appearance and smooth texture. It breaks with a sharp snap, sets up rapidly, and releases easily from molds.

Molding of chocolate: A thin layer of chocolate is brushed into the plastic ice tray mold and the hot tempered chocolate was poured and allowed to settle.

Refrigeration: The molded chocolate is kept in home refrigerator evaporator section to achieve its solid shape of pyramid frustum.

Storage: The chocolate prepared should be stored in an air tight container inside refrigerator.

Chemical analysis: Chemical analysis was done by kjeldahl method as follows

Digestion: Place two digestion tablets into a digestion tube. Weigh approximately 1 g of sample (to a precision of two decimal places) using a weighing boat. Quantitatively transfer the sample into the digestion tube using 12 ml of concentrated sulphuric acid. After shaking it in a circular fashion, place the tube in a digestion stand. Attach a vapor exhauster, switch a water vacuum aspirator on and set the recommended digestion temperature (i.e. 420 °C). After the required temperature is reached (approx. 15 minutes), digest the sample for 40 minutes. Switch the digestion unit off and let the stand with the digestion tubes cool down in a separate place (approx. 20 minutes).

Distillation using the distillation unit KJELTEC 1002**Sample distillation**

First of all in distillation, dilute the cool digest by adding 30 ml of distilled water, and place the tube into the distillation unit. Place a titration (receiver) flask containing 25 ml sulphuric acid ($c = 0.05 \text{ mol/l}$) and a few drops of Tashiro indicator into the unit, and raise the platform. Make sure that the end of the cooler is under the surface; if not, add a small amount of distilled water. Close the safety window and gently press the alkali handle all the way down to dispense 45 ml 45% (w/w) sodium hydroxide solution after that open the steam valve by pulling the handle down and set the timer to 3.5 minutes. After hearing the signal, lower the platform with the receiver flask so that the end of the cooler is above the surface and close the steam valve. Open the safety window, remove the tube and discard the content into the sink with cold running water. We got the contents of the receiver flask is ready for titration

Sample titration: Titrate the contents of the receiver flask with sodium hydroxide solution ($c = 0.1 \text{ mol/L}$) to the neutral endpoint. Record the volume of hydroxide required.

Table 2: Observation table for protein determination

Sample No.	Burette Reading (ml)	Protein (%)
1	26.6	13.47
2	27.7	12.88
3	22.0	16.40
4	38.0	06.73
5	36.0	08.98

Determination of moisture content (by AOAC 1997)**Procedure**

The moisture was determined by the method described by AOAC which any researchers like Kent-Jones *et al.* 1962 followed. Firstly weight of empty Petri dish was taken by the help of electronic balance. 2g of every sample was weighed in flat bottom dried tarred dish having a diameter of 1.5-2.5 inch and a bioht of about two inch, provided with a close fitting but easily removable lid. The covered dish with its lid was placed in hot air oven which was thermo statistically controlled at 110±10 °C and headed until successive weighing showed no further weight loss. At the end, the dish was removed from the oven and placed in desiccators and allowed to cool and then again weighed. Determination of moisture content was done by hot air oven method. The percent moisture content was calculated by the following formula.

$$\text{Moisture\%} = \frac{W_1 - W_2}{W_1 - W} \times 100$$

Where,

W_1 = weight of the dish with the material before drying, gm

W_2 = weighting of the dish with the material after drying, gm

W = weight of the empty dish, gm

Determination of Ash Content

Procedure: 2 g of sample was weighed accurately into a crucible. It was subjected to heating on low flame until the material was completely charred. It was followed by heating in a muffle furnace for 3-5 hours at 600 °C. After that it was cooled in desiccator and weighed. To ensure the completion of ash, crucible is reheated for an hour, cooled, and weighed. Ash content was calculated by using the following formula (Ranganna. S, 2007)

$$\text{Ash\%} = \frac{W_2 - W_1}{W} \times 100$$

Where,

W_2 = final weight of the dish with the ash, gm

W_1 = weight of the empty dish, gm

W = weight of the sample, gm

Determination of fat (Soxhlet Extraction Method) AOAC Method**Procedure**

Accurately weigh 3-4gm chocolate sample. Add slowly, while stirring boiling water to homogeneous suspension. Add 55 ml Ca, 8 ml HCL and few departed Sic chips or other anti-bumping agent, and stir. Cover with watch glass, bring slowly to boil, and boil gently 15 min. Rinse watch glass with 100 ml H₂O. Filter digest through 15 cm S&S 589 medium fluted paper or equivalent, rinsing beaker three times with H₂O. Continue washing until last portion filtrate is Cl-free as determined by addition of 0.1 M AgNO₃. Transfer wet paper and residue to defatted extraction thimble and dry 6-18 h in small beaker at 100 °C. Place glass wool plug, over the paper. Add few defatted and bumping chips to 250 ml. Erlenmeyer and dry 1 h at 100 °C. Cool to room temperature in desiccator and weigh. Place thimble containing dried residue in Soxhlet supporting it with spiral or glass beads. Rinse digestion beaker, drying beaker and watch glass with the 50 ml, portions petroleum ether, and add washings to thimble. Reflux digested residue 4 h adjusting heat so that extract or siphon 30 times/h or condensation rate of 5-6 drops/s.

Removes flask, and evaporate solvent on steam bath. Dry flask at 100 °C-101 °C to constant weight (1.5-2 hr). Cool in desiccator to room temperature and weigh. Constant weight is attained when successive 1 h drying periods show additional loss of < 0.05% fat.

Determination of starch

Procedure: Weigh the sample material containing up to 2 g starch into a centrifuge tube, wash it three times with 15 ml ethanol (40%; v/v) each while stirring for 20 min at 20-25 °C, centrifuge, remove the supernatants. Add 10 ml HCl (1 part HCl, 32%; m/m; diluted with two parts of resin water) to the residue and stir for 60 min at 60 °C in a water bath. Transfer the solution quantitatively into a 100 ml beaker, rinse with water and adjust the pH to approx. 4.5 by the addition of NaOH (5 M). Transfer the solution into a 100 ml volumetric flask, rinse with water, fill up to the mark, mix and filter if necessary. Prepare a solution add 5 ml of Folin A, Folin B and 50 ml water to the, and add methyl blue indicator to form a solution. Heat the solution till it boils and adds glass beads to the solution for constant heating. Shake the solution and heat constantly in a conical flask. In a burette add the prepared starch indicator and fill it to the marked level of burette. Titrate the starch solution against the heated solution of indicators and note the reading.

Table 3: Observation table for carbohydrate

Sample No.	Burette Reading (ml)	Carbohydrates (%)
1	50.67	11.47
2	58.89	11.47
3	102.3	5.56
4	33.79	17.2
5	25.38	22.9

Determination of Glucose by Titration with Fehling's Reagent**Fehling's Standardization Procedure**

Accurately transfer 10.00 ml Fehling's solution A and 10.00 ml Fehling's solution B into a 250 ml Erlenmeyer flask. Use a separate volumetric pipette for each solution. Add approximately 30 ml of DDI water & mix well. Fill burette with dextrose standard. Make sure to drain to remove any bubbles. Place flask on a hot plate turned to a medium heat. Heat to at least 70 °C but below boiling (use a thermometer). Throughout the titration, continue to monitor the temperature to make sure to keep the temperature of the solution consistently above 70 °C. Remember that the addition of the dextrose titrant will cause the solution to cool. Add dextrose standard until blue color nearly disappears. The mixture will remain a murky blue-gray with a reddish precipitate but won't completely clear up. After the color mostly disappears (or after ~10 ml of added dextrose, whichever comes first), add 1 or 2 drops (no more) of methylene blue indicator. Continue adding dextrose standard until the blue color disappears entirely and only a colorless solution with a red precipitate is present. It will help to hold a piece of white paper behind the flask. Using the concentration of dextrose in your titrant and the volume of the dextrose solution used for the titration, determine the mass of dextrose that reacts per ml of Fehling's reagent. ("Fehling's reagent" refers to the mix of 10 ml each of stock solutions A and B.) Repeat the titration at least three times.

Physical analysis

The physical parameters that have been analyzed by using following formulae:

$$\text{Surface area} = f + a + b$$

$$\text{Lateral Area} = 2(a + b)\sqrt{e(a - b)/2} + h$$

$$\text{Volume} = \frac{h}{3} (a + b) + \sqrt{ab}$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Where:

a = Lower length, b= Upper length, h= height, f= lateral area

Sensory analysis

The judgment was made by rating product on a 9 point hedonic scale with corresponding descriptive term ranging from 9 “like extremely” to 1 “dislike extremely”

Result and Discussion

Preparation of handmade stevia chocolate

During the chocolate making process, Milk chocolate is made by adding milk powder, stevia, cocoa butter and other ingredients to the bitter chocolate liquor. At this point, Chocolate is prepared in according to individual recipes. The blending of the various types of cocoa pastes and other ingredients determine the ultimate taste. The ingredients go into a mixer with rotating, kneading arms until the result is a

homogeneous, paste-like mixture with a pleasant taste, but it still feels gritty to the palate. This process develops flavors and changes the texture during controlled temperatures. It's the last and most important refining process, which allows the separate flavors of the individual ingredients to combine. Conching process can eliminate any remaining bitterness by aerating the chocolate and expelling volatile acids. Additional cocoa butter added which help to achieve the characteristic velvet smoothness. And as the ultimate homogeneity of the ingredients is developed, a soft film of cocoa butter begins to form around each of the extremely small particles. The chocolate no longer seems sandy, but dissolves meltingly on the tongue. It has attained the outstanding purity which gives it its reputation.

The experiment was conducted for development and quality evaluation of handmade sugar free chocolate made with stevia as sweetener. The present investigation was undertaken to evaluate the quality as well as acceptability of utilization of stevia for the preparation of handmade chocolate. The physical, chemical and sensory evaluation of handmade stevia chocolate has been carried out.

Development of handmade stevia chocolate

Studies on quality were based on physio-chemical and sensory properties, which were determined for developed handmade stevia chocolate.

Table 4: Composition table of chocolate

Sample No.	Sample	Cocoa butter (ml)	Unsalted butter (ml)	Cocoa powder (gm)	Stevia (gm)	Milk powder (gm)
1	Milk chocolate	20	40	25	25	50
2	Dark Chocolate	10	40	38	38	55
3	Skimmed milk Chocolate	10	30	25	25	50
4	Chocolate with starch ratio 2:1	15	35	25	25	25
5	Chocolate with starch ratio 1:2	15	40	25	30	25

In accordance to the various samples the maximum moisture content was found in sample 4 and sample 5 whereas the minimum amount was found in sample 2. The average least ash content was found in sample 5 and maximum in sample 3. The average consumable amount of protein was found in sample 1 least in sample 5 while highest in sample 3. The

average acceptable amount of starch was found in sample 5, least amount in sample 3 while highest in sample 5. The average acceptable amount of sugar was found in sample 1 whereas highest in sample 3, least amount of sugar was observed in sample 5 which can be considered as sugar free sample which can be consumed by diabetic patient

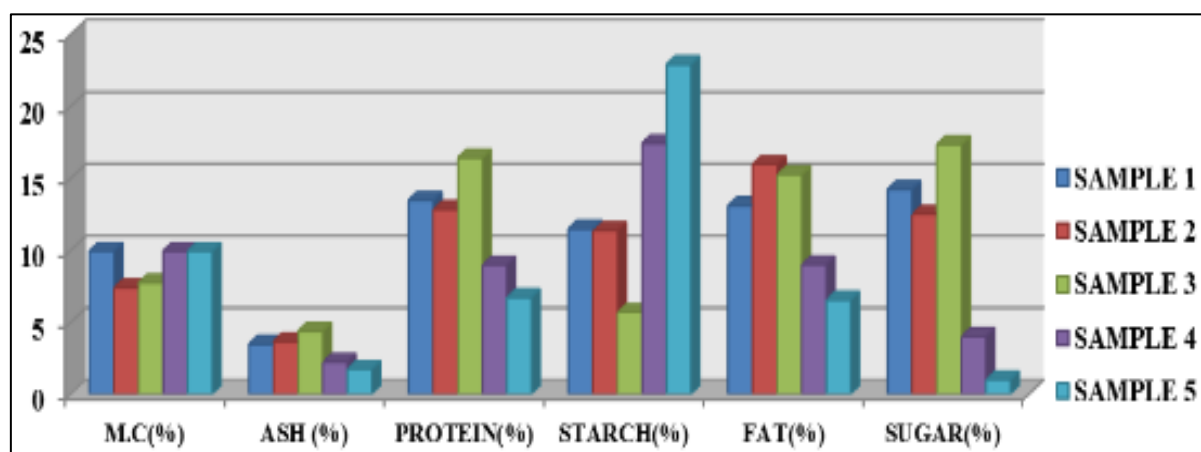


Fig 2: Physio-chemical analysis of samples

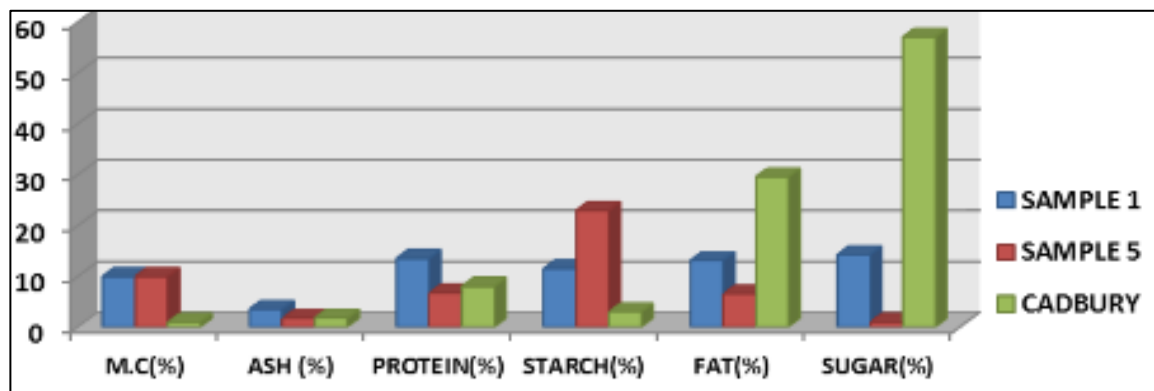


Fig 3: Comparison of Cadbury dairy milk with developed samples

Figure 3 shows the relative comparison between the brand Cadbury dairy milk and the sugar free sample developed. It was observed that in sample 5 sugar content was least as compared to Cadbury. The fat percentage in Cadbury was found to be much above the acceptable range. The least amount of moisture content was found in Cadbury sample due to its high percentage in fat. The binding of the chocolate is greatly affected by process of conching which removes the volatile acids present in chocolate, it also smoothens the chocolate and round out the flavor, which is essential for the flavor, the texture and the overall quality of the chocolate. In sample 1 and sample 5 least required amount of butter was added to reduce the fat percentage chemically present in the chocolate. Since the chocolate was handmade without using machining process, it was difficult to maintain and reduce the amount of moisture present in chocolate.

Sensory evaluation

Sensory evaluation of five chocolate samples was done by semi skilled panel. Table is drawn and graph is plotted on the basis of average of three samples and two starch sample of chocolate.

Table 5: Sensory evaluation for milk and starch chocolate

Characteristics	Milk chocolate	Starch chocolate
Color	7	8
Taste	7	9
Texture	8	9
Appearance	8	7
Overall acceptability	8	9

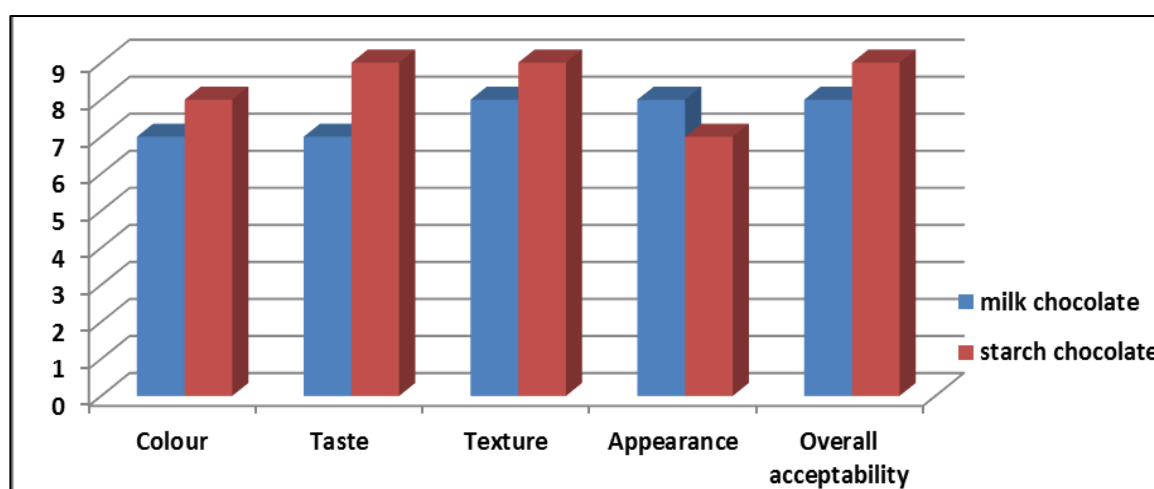


Fig 4: Sensory evaluation of milk chocolate and starch chocolate

Table 6: Physical characteristics

S. No	Measurement	Values
1.	Upper Length	32.7 mm
2.	Lower Length	40.4 mm
3.	Upper Width	16.6 mm
4.	Lower Width	24.3 mm
5.	Slant Height	13.7 mm
6.	Height	12.9 mm
7.	Surface Area	$4.669 \times 10^3 \text{ mm}^2$
8.	Volume	$17.297 \times 10^3 \text{ mm}^3$
9.	Density	$4.7 \times 10^{-3} \text{ g/mm}^3$
10.	Weight	7.2 gm
11.	Mass	70.56 gm

Conclusion

So far we developed different kind of chocolate with the incorporation of natural sweetener with different ratio and proportion and the chemical as well as rheological properties were up to the mark. The test has been conducted very preciously under the expertise of scientists of reputed food industries and the result concluded that the natural sweetener can surely be replaced in order to replicate the original chocolate in an organic as well as healthy need of purpose.

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