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Development and standardization of monk fruit sweetened chocolate protein shake-guilt-free alternative to chocolate shake

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Abstract

The study presents the development of chocolate flavoured Monk Fruit Sweetened Protein Shake (MFSPS). The formulation was aimed to enhance nutritional value, sensory acceptability, and product sustainability. The protein shake composed of whey protein isolate, Monk Fruit Extract (MFE), Skim Milk Powder (SMP), unsweetened cocoa powder and blended with water. *Siraitia grosvenorii* (Monk fruit) extract in powder form was used as a low-calorie natural sweetener. Whey protein isolate is used as a base formulation in the product as protein supplement. Other ingredients used SMP, and unsweetened cocoa powder were added to provide flavour profile and overall mouthfeel. Additionally, additives like xanthan gum and potassium sorbate were used to maintain physicochemical stability and microbiological safety respectively. Xanthan gum was added to maintain stability by preventing coagulation of protein due to pasteurization. Potassium sorbate at the rate of 1000 ppm was added to extend the shelf life of the product. The developed MFSPS contains balance amount of carbohydrate (2.08g), protein (11.04g), and fat (0.38g). Sensory evaluation was conducted to understand product acceptability. The product shows an average overall acceptability score of 7.25 on a 9-point Hedonic scale, indicating good consumer preference. Based on its nutritional composition and low glycaemic profile, the formulated product is ready for commercialization and can be recommended for athletes as recovery drink and those seeking low sugar, low calories options.

Keywords: Low calories, macronutrients, monk fruit, physicochemical analysis, protein shake

Introduction

Sweetness is one of the fundamental human pleasures. However, while satisfying this need, the consumption of sugar has increased a great deal. But higher consumption of sugar has led to many conditions like obesity, diabetes and cardiovascular diseases even among the younger generations. To cope up with this, manufacturers have started making use of noncaloric artificial sweeteners such as sucralose, acesulfame K, etc. Even though they have a general acceptance for consumption, recent research has shown their side effects on the intestinal microbiome, which can lead to metabolic syndrome and glucose intolerance. Taking into consideration the problems associated with natural sugar and non-caloric artificial sweeteners, now the natural sweeteners come into picture to satisfy the human need (Itkin *et al.*, 2016) ^[1].

Monk fruit, *Siraitia grosvenorii*, an herbaceous perennial plant, native to the southern parts of China is widely used as a non-caloric natural sweetener. It contains cucurbitane-type triterpene glycosides known as Mogrosides. Monk fruit extract is said to be 300 times sweeter than sucrose. Despite its importance and rising demand monk fruit is not cultivated outside China because of lack of information regarding its farming and cultivation (Shivani *et al.*, 2021) ^[2]. Protein beverages have an increased demand among the youth of today. Students and working generation have a new-found attraction towards gym and bodybuilding. One of the most common protein sources is whey protein in two forms, whey protein isolate, or whey protein concentrate which are both extracted by membrane filtration of liquid whey. Whey protein is a complete source of amino acids and are high in branched-chain amino acids that aid in muscle recovery which make it an ideal source for protein shakes (Parker *et al.*, 2018) ^[3].

Chocolate shake has an increased demand among children, but higher sugar content increases health concerns. The concept of sugar reduction and parents' preference for non-caloric natural sweeteners further necessitates the cause for research (Li *et al.*, 2015) [4]. A combination of chocolate, protein and natural sweeteners will surely gain the interest of consumers.

Materials and Methodology

Materials

The raw materials used in the formulation are water (85.9%), unflavoured whey protein isolate (6%), SMP (5.5%), cocoa powder (1.2%), MFE (1%), xanthan gum (0.2%), potassium sorbate (0.1%), salt (0.1%). The rest of the raw materials were sourced and procured from E-commerce platform, Amazon. All the raw materials used for developing the product are of food-grade and safe for human consumption. The product trials and final production was done at Food Process and Product Technology lab of School of Food Technology, MIT ADT University and Pune from the month of January to April 2025.

Formulation and Preparation

The standardized formulation of chocolate whey protein shake was developed for 100ml serving. All the dry ingredients (whey protein isolate, SMP, cocoa powder, MFE, xanthan gum, potassium sorbate, and salt) were accurately weighed using an electronic digital balance and mixed thoroughly. The dry mix was then gradually reconstituted in room temperature water with continuous stirring to prevent lumps. This solution was blended at 5000 rpm for 1 minute. The homogenized shake was pasteurized at 72°C for 15 seconds and rapidly cooled to 10°C. The product is then filled into sterilized Polyethylene Terephthalate bottles and stored at 4°C.

Physicochemical Analysis:

Moisture Content: Moisture content was determined using hot air oven method at 105±2°C until constant weight, as per. The% moisture was calculated as per the formula given in equation (1).

$$\text{Moisture\%} = \frac{M_1 - M_2}{M_1 - M_0} \times 100 \quad (1)$$

Where,

M_0 = Wt. of empty dish

M_1 = Wt. of dish + Wt. of Sample before drying

M_2 = Wt. of dish + Wt. of Sample after drying

Titrate Acid: Estimated by titration using 0.01N NaOH with phenolphthalein indicator and calculated as% lactic acid. The% acidity was calculated as per the formula given in equation (2).

$$\text{Acidity\%} = \frac{\text{ml} \times \text{N} \times 90 \times 100}{\text{V} \times 100} \quad (2)$$

Where,

ml = Volume of NaOH used

N = Normality of NaOH

V = Volume of Sample used

pH: Measured using pH indicator paper strips, with results taken immediately after processing. The principle behind pH

is based on the concentration of hydrogen ions (H^+) in a solution. pH is a measure of how acidic or basic a solution.

Total Soluble Solids (TSS): TSS is measured using a Refractometer, which determines the of concentration of soluble solids in a liquid and is expressed in degree Brix. A 0 to 30° Brix range refractometer was used to measure TSS of MFSPS (I.S. 13815:1993/I.S.O. 2173:1978).

Macronutrient Analysis: Protein, fat, carbohydrate and energy values were estimated using lab estimation methods and calculations.

Protein, the% nitrogen content was calculated as per the formula given in equation (3)

$$\text{Nitrogen\%} = \frac{1.4 \times V \times N}{W} \quad (3)$$

Where,

V = Volume of acid used (ml)

N = Normality of standard acid

W = Weight of Sample

The% protein content was calculated as per the formula given in equation (4)

$$\text{Protein\%} = \% \text{Nitrogen} \times \text{Conversion Factor (6.25)} \quad (4)$$

Fat, was conducted by Gerber's Method using Gerber Butyrometer.

The% carbohydrate content was calculated as per the formula given in equation (5)

$$\text{Carbohydrate\% (by difference method)} = 100 - (\text{Moisture} + \text{Protein} + \text{Fat}) \quad (5)$$

The Energy content was calculated as per the formula given in equation (6)

$$\text{Energy (Kcal)} = (\text{Protein} \times 4) + (\text{Fat} \times 9) + (\text{Carbohydrate} \times 4) \quad (6)$$

Microbial Analysis

- Microbiological analysis was estimated based on FSSAI 2020 General Standards for Milk and Milk Products.
- Total Plate Count (TPC) using plate count agar at 37°C for 48 hours.(IS 5402 (2012) of Indian Standards, N.D.-b)
- Yeast and Mould Count (YMC) using potato dextrose agar at 37°C for 5 days.(IS 5403 (1999) of Indian Standards, N.D.-c)
- Coliform Count (CC) using Mac Conkey Broth.(IS 5401-1 (2012) of Indian Standards, N.D.-a)

Sensory Evaluation

A 9-point Hedonic scale was used to find out the beverage's colour, flavor, texture, mouth feel and overall acceptability. The sensory evaluation was carried out by the faculty and students at School of Food Technology under proper conditions.

Results and Discussion

Physico-Chemical Analysis

The development and formulation of MFSPS was acceptable in terms of its sensory attributes, microbial stability and physico-chemical properties. The study evaluated that the product is preferred by participants after conducting sensory rating and can be a good option for those who consume regularly sweetened protein shakes. A similar reduced sugar chocolate flavoured milk was developed using monk fruit by Mahato *et al.*, (2022) [8].

Table 1: Physicochemical analysis of MFSPS

Sr. No.	Parameters	Result
1.	Moisture %	86.45±1.62
2.	Acidity %	0.14±0.01
3.	pH	5.5±0.5
4.	TSS (°Brix)	16±1

As per the results cited in Table 1 present the physicochemical analysis of the sample, which include moisture content, acidity, pH, TSS. Each parameter was assessed on three observations, and the result were expressed as mean and standard deviation. As the 85% of the formulation is water based, contributing to 86.45%±1.62 of moisture content. The acidity was measured at 0.14%±0.01, and pH at 5.5±0.5, observing a mild acidic profile, primarily contributed by whey protein isolate, monk

fruit powder, SMP, and cocoa powder because of the presence of organic acid and protein. The TSS was observed at 16±1 Brix, contributed by monk fruit sweetener, SMP, and whey protein isolate. This study provides insight into the physicochemical characteristics of the sample, which are essential for understanding the quality and stability of the product.

Table 2: Macronutrient analysis of MFSPS

Sr. No.	Parameters	Result
1.	Energy (kcal)	55.9
2.	Carbohydrates (g)	2.08
3.	Protein (g)	11.04
4.	Fat (g)	0.38

As per the results cited in Table 2 shows the macronutrient analysis per 100ml of the sample. Energy is 55.9 kcal, Carbohydrates are 2.08g, Protein 11.04g, and Fat 0.38g. These findings represent the nutritional information and the product composition. The MFSPS offers an affordable and approachable alternative to expensive commercial protein drinks. The utilization of such high quality yet common available ingredients with no special processing skills provides a convenient and cost-effective option.

Microbial Analysis

Table 3: Microbial Analysis of MFSPS

Sr. No.	Parameters	Media Used	Units	FSSAI Limit(9)	Observation	Inference
1.	Total Plate Count (TPC)	Plate Count Agar	CFU/ml	$\leq 10^4$ CFU/ml	1.0×10^2 CFU/ml	Complies
2.	Yeast and Mould Count (YMC)	Potato Dextrose Agar	CFU/ml	NA	6×10^1 CFU/ml	Complies
3.	Coliform Count (CC)	Mac Conkey Broth	MPN/ml	<10/ml	2/ml	Complies

Table 3, shows the microbial analysis of the sample which include TPC, YMC and CC. The TPC, YMC and CC were observed 1.0×10^2 CFU/ml, 6×10^1 CFU/ml and 2/ml respectively. This table gives information about the microbial analysis conducted which is necessary to assess the quality of the product and estimate its shelf life.

Sensory Analysis

The results cited in figure no. 1 indicate that the developed MFSPS was well accepted by the panelists. The average score was calculated to present the overall acceptability of each sensory attribute. The product showed a homogenous appearance with no sedimentation or separation because of xanthan gum stabilizer. Panelists appreciated the mild sweet flavor profile contributed by monk fruit sweetener. The texture and mouthfeel of the sample was described by panelists as smooth and creamy with minimal off flavors associated with whey protein isolate. These findings indicate good consumer liking, and the average score 7.25 resulted strong overall acceptability. The formulation naturally sweetened high protein shake successfully achieved appealing sensory acceptance. According to Ban *et al.*, (2020) [10] use of MFE suggests it could be suitable natural sweetener in yoghurt and other food products application.

Conclusion

The development and standardization of the MFSPS is a significant innovation towards formulation of health and nutrition-dense version of chocolate shakes. By utilizing natural sweeteners like MFE and high-quality whey protein

isolate, the formulation achieves the low-calorie, high-protein nature while maintaining good sensory and physicochemical properties. The product exhibited microbial safety, long shelf-life, and was highly acceptable during sensory evaluation, validating its acceptability and possible appeal to health-oriented consumers. Due to its low cost, ease of preparation, and nutritional advantages, MFSPS is suitable for commercial production, especially for guilt-free indulgence and functional nutrition product.

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