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Chemical analysis of sugar-free Gulabjamun prepared from Gulabjamun mix by using skim milk powder, soy flour and low calorie sweeteners

Chandra Shekhar Mourya and Sahja Nand Thakur

Abstract

Research was conducted to examine Sugar-free Gulabjamun Prepared from Gulabjamun mix by using skim milk powder, Soy flour and low calorie sweeteners. The objective of the present research was to develop improved sugar free Gulabjamun with health benefits beyond those of traditionally formulated Gulabjamun. Using skim milk powder, maida, soy flour, Vanaspati and backing powder to improve the functional qualities of formulated gulabjamun. With packaging materials (LDPE and aluminium foil) 15 day interval (0-60 day) and low calorie sweeteners i.e. stevia, sucralose and herbal sugar. These treatment combination(G₁, G₂, G₃, G₄, G₅, G₆, G₇, G₈, G₉, G₁₀, G₁₁, G₁₂, G₁₃, G₁₄, G₁₅, G₁₆, G₁₇, G₁₈, G₁₉, G₂₀, G₂₁, G₂₂, G₂₃, G₂₄) used in the study were replicated five times. Products were tested for moisture, fat, protein, carbohydrate, Acidity, ash, Energy, Total Sugar, Total soluble solids (TSS), hardness, cohesiveness, gumminess, springiness and Chewiness. Cost of the product was also worked out for different treatment combinations. The data obtained during investigation were statistically analyzed by using factorial design and critical difference between treatment combinations. The average composition of sugar free gulabjamun was moisture 34.47 per cent, fat 5.44 per cent, protein 8.41 per cent, carbohydrate 50.10 per cent, acidity 0.514 per cent, ash 1.56 per cent, Energy 292.23 Kcal/100g, Total sugar i.e. stevia 19.48 per cent, sucralose 23.65 per cent, herbal sugar 55.03 per cent, Total soluble solids (T.S.S.) 61.40 per cent.

Keywords: Sugar free Gulabjamun, Skim milk powder, Maida, Vanaspati, Soya flour, LDPE, Aluminium foil, Stevia, Sucralose, Herbal sugar

Introduction

Gulabjamun is a popular sweet prepared in all parts of India. Like other sweets, the manufacture of gulabjamun is also largely in the hands of halwais who adopt small scale batch method. Though there is large variations in the sensory quality of gulabjamun, the most liked product should have brown colour, smooth and spherical shape, soft and slightly spongy body free from both lumps and hard central core, uniform granular texture, mildly cooked and oily flavor, free from doughy feel and fully succulent with sugar syrup. It shall have optimum sweetness. It may or may not contain a piece of cashew nut in the center (Lad *et al.*, 2017). Khoa is an indigenous milk product prepared by concentration of milk and is widely used in India and in neighboring countries as a base material for preparation of numerous sweets like Penda, Burfi, Gulabjamun, Kalakand, etc. Khoa is classified into three different categories by BIS (IS: 4883-1980) depending upon its texture and its composition are Pindi, Dhap and Danedar. Among this three type, Dhap khoa is preferable for Gulabjamun. This type is characterized by loose and sticky body and smooth texture. It is normally pre-pindi stage and thus contains higher moisture so that balls of smooth surface can be prepared Kant and Broadway (2017). Gulabjamun refers to the indigenous dairy product. Almost all the states of the country use Gulabjamun as one of the essential and most commonly consumed sweet. Different states using different shapes and size of Gulabjamun *viz*; cylindrical, oval and spherical, but most commonly found shape is spherical. The gross chemical composition of Gulabjamun varies widely depending on numerous factors, such as composition and quality of Khoa, proportion of ingredients, sugar syrup concentration, etc. The composition of Gulabjamun, on the drained weight basis, varies in the following range: moisture 25 – 35 percent, fat 8.5 – 10.5 percent, protein 6 – 7.6 per cent, ash 0.9 – 1.0 per cent and total carbohydrates 43 – 48 per cent (Singh *et al.*, 2018) [2].

Skim milk powder

Over the years, a number of different types of milk powders have been explored for use in dairy product. These include roller-dried and spray-dried whole milk powders (WMP), high-fat powders, buttermilk powders, whey powders, and skim milk powder sprayed with anhydrous milk fat (AMF) or cream. The characteristics of these powders are quite different, although they may have similar composition (Liang and harte, 2004) ^[14].

Soy flour

Soybean flour a self-pollinated crop is one of the most important oil and protein crops of the world. The soybean is an excellent source of major nutrients including a good source of vitamins and minerals (Islam *et al.*, 2007). As an important component crop, soybean the legume richest in nutrients and the one from which the most dietary products are made is used in various traditional farming systems of various countries (Sanful and Darko, 2010).

Maida (Refined wheat flour)

Refined wheat flour or maida is generally used as a binder for preparation of gulab jamun. The type of binder and content play an important role in deciding the composition, rheology and sensory attributes of gulab jamun (Joshi *et al.*, 2009).

Materials and Methods

The experiment "Production and Quality Evaluation of Sugar-free Gulabjamun Prepared from Gulabjamun mix by using skim milk powder, Soy flour and low calorie sweeteners" was conducted in the Research Lab of Regional food research & analysis centre (Department of horticulture and food processing, Utter Pradesh) Udyan Bhawan Campus, 2-Sapru marg, Lucknow The experimental techniques were employed as under.

Treatment combination

The product (Gulabjamun mix) was manufactured by different treatment combination such as skim milk powder, maida, soy flour, Vanaspati, baking powder i.e. T₁ (53:15:12:18:02), T₂ (50:16:12:20:02), T₃ (47:17:12:22:02), and T₄ (44:18:12:24:02). The different treatment combinations used in the experiment were represented as follows:

Table 1: Details treatment combination

Ingredients	Percentage (%)			
	Treatments			
	T ₁	T ₂	T ₃	T ₄
Skim milk powder*	53	50	47	44
Maida	15	16	17	18
Soy Flour	12	12	12	12
Vanaspati	18	20	22	24
Baking powder	2	2	2	2

Packaging materials

- Low-density polyethylene (LDPE) Thickness- 60µ of 100g capacity.
- PE (plotline) / Aluminum foil / PE lameded Thickness – 70µ of 100g capacity

Details of sugar free gulabjamun treatment combination

Twenty four different combination of sugar free gulabjamun

Prepared from Gulabjamun mix by using skim milk powder, Soy flour and low calorie sweeteners i.e. (stevia, sucralose and herbal sugar) the details of the prepared combination were as follows.

G₁- Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18% Vanaspati and 2%Baking powder, Packed by LDPE, Stevia 50% brix sugar syrup.

G₂- Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20% Vanaspati and 2%Baking powder, Packed by LDPE, Stevia 50% brix sugar syrup

G₃- Prepared by the combination of 47% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22% Vanaspati and 2%Baking powder, Packed by LDPE, Stevia 50% brix sugar syrup.

G₄- Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24% Vanaspati and 2%Baking powder, Packed by LDPE, Stevia 50% brix sugar syrup.

G₅- Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18% Vanaspati and 2%Baking powder., Packed by Aluminum foil, Stevia 50% brix sugar syrup.

G₆ - Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20% Vanaspati and 2%Baking powder, Packed by Aluminum foil, Stevia 50% brix sugar syrup.

G₇ - Prepared by the combination of 47% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22% Vanaspati and 2%Baking powder, Packed by Aluminum foil, Stevia 50% brix sugar syrup.

G₈ - Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24% Vanaspati and 2% Baking powder, Packed by Aluminum foil, Stevia 50% brix sugar syrup.

G₉ - Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18% Vanaspati and 2%Baking powder, packed by LDPE, Sucralose 50% brix sugar syrup.

G₁₀ - Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20% Vanaspati and 2%Baking powder, packed by LDPE, Sucralose 50% brix sugar syrup.

G₁₁ - Prepared by the combination of 50% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22% Vanaspati and 2%Baking powder, Packed by LDPE, Sucralose 50% brix sugar syrup.

G₁₂ - Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24% Vanaspati and 2%Baking powder, Packed by LDPE, Sucralose 50% brix sugar syrup.

G₁₃ - Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18% Vanaspati and 2%Baking powder, Packed by Aluminum foil, Sucralose 50% brix sugar syrup.

G₁₄–Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20% Vanaspati and 2%Baking powder, Packed by Aluminum foil, Sucralose 50% brix sugar syrup.

G₁₅ - Prepared by the combination of 47% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22% Vanaspati and 2%Baking powder, Packed by Aluminum foil, Sucralose 50% brix sugar syrup.

G₁₆ - Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24%Vanaspati and 2%Baking powder, Packed by Aluminum foil, Sucralose 50% brix sugar syrup.

G₁₇- Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18%Vanaspati and 2% Baking powder, Packed by LDPE, herbal sugar 50% brix sugar syrup.

G₁₈ - Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20%Vanaspati and 2%Baking powder, Packed by LDPE, herbal sugar 50% brix sugar syrup.

G₁₉ - Prepared by the combination of 47% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22%Vanaspati and 2%Baking powder, Packed by LDPE, herbal sugar 50% brix sugar syrup.

G₂₀ - Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24%Vanaspati and

2%Baking powder, Packed by LDPE, herbal sugar 50% brix sugar syrup.

G₂₁ - Prepared by the combination of 53% Skim milk powder (spray dried), 15%Maida, 12%Soy flour, 18%Vanaspati and 2% Baking powder, Packed by Aluminum foil, herbal sugar 50% brix sugar syrup.

G₂₂ - Prepared by the combination of 50% Skim milk powder (spray dried), 16%Maida, 12%Soy flour, 20%Vanaspati and 2%Baking powder, Packed by Aluminum foil, herbal sugar 50% brix sugar syrup.

G₂₃ - Prepared by the combination of 47% Skim milk powder (spray dried), 17%Maida, 12%Soy flour, 22%Vanaspati and 2%Baking powder, Packed by Aluminum foil, herbal sugar 50% brix sugar syrup.

G₂₄ - Prepared by the combination of 44% Skim milk powder (spray dried), 18%Maida, 12%Soy flour, 24%Vanaspati and 2% Baking powder., Packed by Aluminum foil, herbal sugar 50% brix sugar syrup.

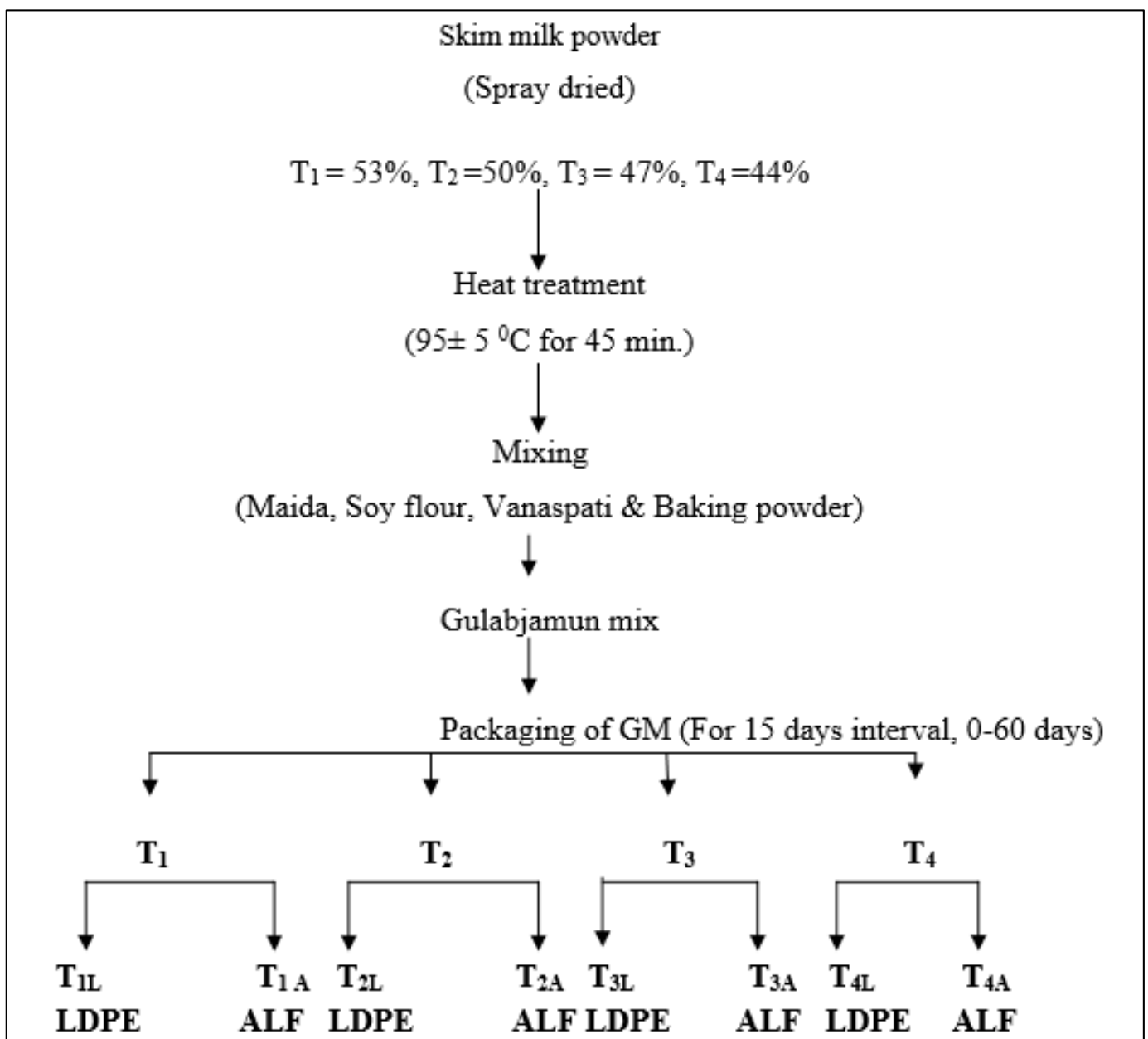


Fig 1: Flow diagram for Preparation of Gulabjamun mix and packaging of gulabjamun mix for 15 day interval (0-60 days).

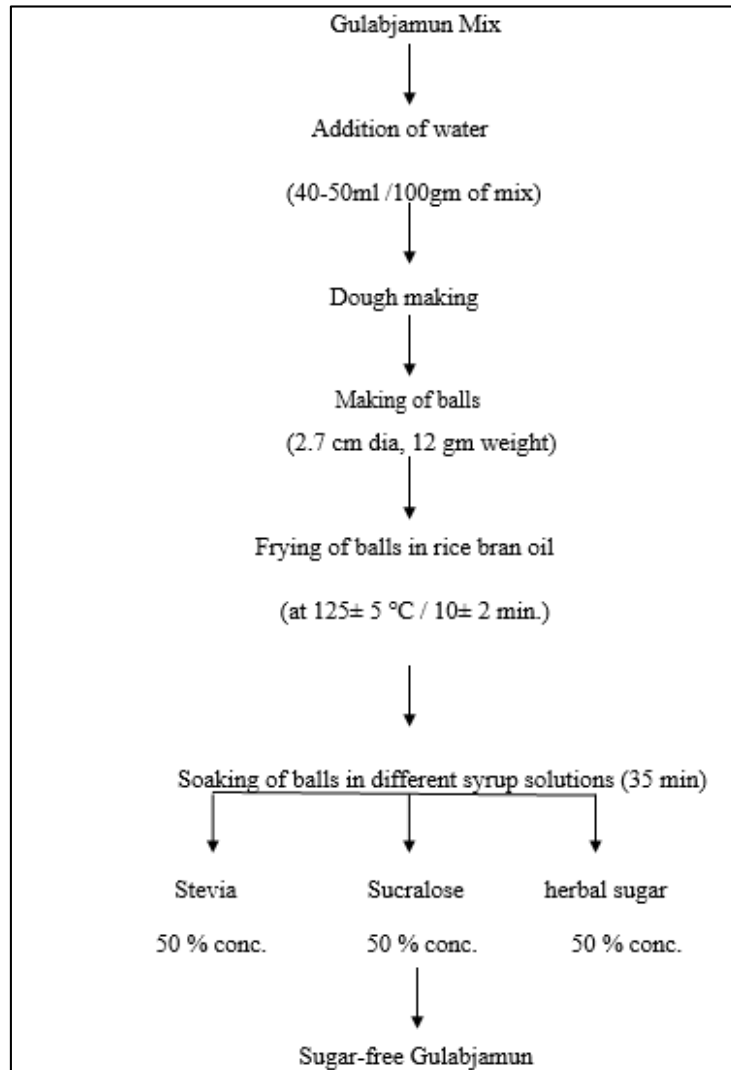


Fig 2: Flow diagram for production of sugar free Gulabjamun

Table 2: Chemical composition of sugar free Gulabjamun prepared from Gulabjamun mix by using skim milk powder, Soy flour and low calorie sweeteners

Treatment combination	Moisture	Fat	Protein	Acidity	Carbo-hydrates	Energy (Kcal/100g)	Ash	Total Sugar	T.S.S
G ₁	34.47	5.44	8.41	0.514	50.10	292.23	1.56	19.58	61.40
G ₂	34.41	6.09	8.09	0.494	49.95	296.27	1.44	19.52	61.50
G ₃	34.35	6.74	7.77	0.454	49.77	300.22	1.35	19.42	61.60
G ₄	34.29	7.39	7.45	0.424	49.59	304.15	1.26	19.39	61.70
G ₅	34.51	5.51	8.45	0.514	49.91	292.25	1.60	19.58	61.40
G ₆	34.45	6.16	8.13	0.494	49.76	296.31	1.48	19.52	61.50
G ₇	34.39	7.01	7.81	0.454	49.38	301.27	1.39	19.42	61.60
G ₈	34.33	7.46	7.49	0.424	49.40	304.16	1.30	19.39	61.70
G ₉	34.47	5.45	8.41	0.514	50.09	292.22	1.56	23.76	61.40
G ₁₀	34.41	6.09	8.08	0.494	49.94	296.24	1.45	23.70	61.50
G ₁₁	34.36	6.74	7.77	0.454	49.75	300.18	1.36	23.64	61.60
G ₁₂	34.29	7.41	7.45	0.424	49.58	304.15	1.26	23.50	61.70
G ₁₃	34.52	5.51	8.45	0.514	49.90	292.26	1.60	23.76	61.40
G ₁₄	34.45	6.16	8.12	0.494	49.76	296.32	1.48	23.70	61.50
G ₁₅	34.39	7.01	7.80	0.454	49.39	301.25	1.40	23.64	61.60
G ₁₆	34.34	7.47	7.49	0.424	49.39	304.19	1.30	23.50	61.70
G ₁₇	34.47	5.45	8.41	0.514	50.09	292.24	1.56	55.11	61.40
G ₁₈	34.41	6.10	8.09	0.494	49.93	296.29	1.45	55.06	61.50
G ₁₉	34.35	6.74	7.77	0.454	49.77	300.22	1.35	55.01	61.60
G ₂₀	34.29	7.40	7.44	0.424	49.58	304.16	1.27	54.94	61.70
G ₂₁	34.51	5.51	8.45	0.514	49.91	292.26	1.60	55.11	61.40
G ₂₂	34.45	6.16	8.13	0.494	49.76	296.30	1.49	55.06	61.50
G ₂₃	34.39	7.01	7.81	0.454	49.39	301.30	1.39	55.01	61.60
G ₂₄	34.34	7.46	7.49	0.424	49.39	304.14	1.31	54.94	61.70

Results and Discussions

Moisture

Effect of different treatment combination, packaging material and different low calorie sweeteners on moisture of sugar free Gulabjamun.

- the treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 34.47, 34.41, 34.35 and 34.29 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 34.51, 34.45, 34.39 and 34.33 at 15 days interval.
- The treatment combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 34.47, 34.41, 34.36 and 34.29 at 15 days interval. The treatment

combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean value (0 to 60 days) respectively 34.52, 34.45, 34.39 and 34.34 at 15 days interval.

- The treatment combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 34.47, 34.41, 34.35 and 34.29 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 34.51, 34.45, 34.39 and 34.34 at 15 days interval.
- The treatment combination that has low moisture is 34.29 and higher is 34.52. there are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different treatment combinations, different packaging material.

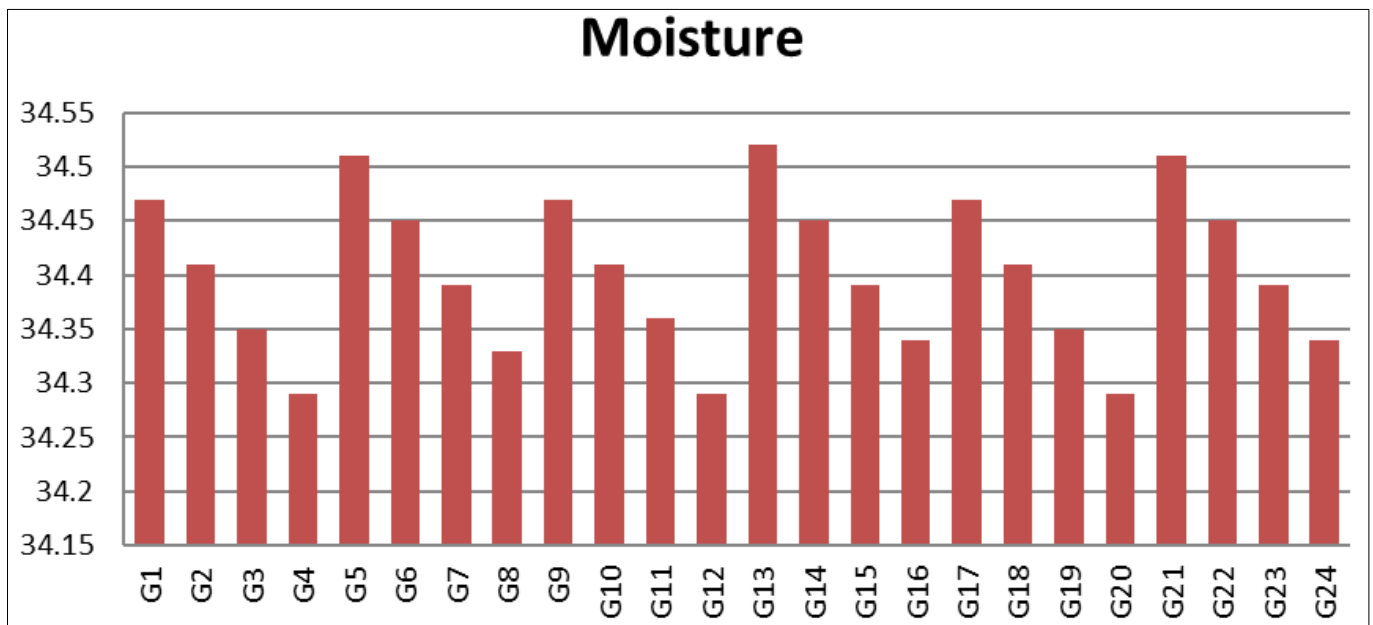


Fig 3: Average Moisture of sugar free gulabjamun by using low calorie sweetener

FAT

Effect of different treatment combination, packaging material and different low calorie sweeteners on fat of sugar free Gulabjamun.

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 5.44, 6.09, 6.74 and 7.39 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 5.51, 6.16, 7.01 and 7.46 at 15 days interval.
- The treatment combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 5.45, 6.09, 6.74 and 7.41 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean

value (0 to 60 days) respectively 5.51, 6.16, 7.01 and 7.47 at 15 days interval

- The treatment combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 5.45, 6.10, 6.74 and 7.40 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 5.51, 6.16, 7.01 and 7.46 at 15 days interval.
- The treatment combination that has low Fat content is 5.44 and higher is 7.47. There is non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

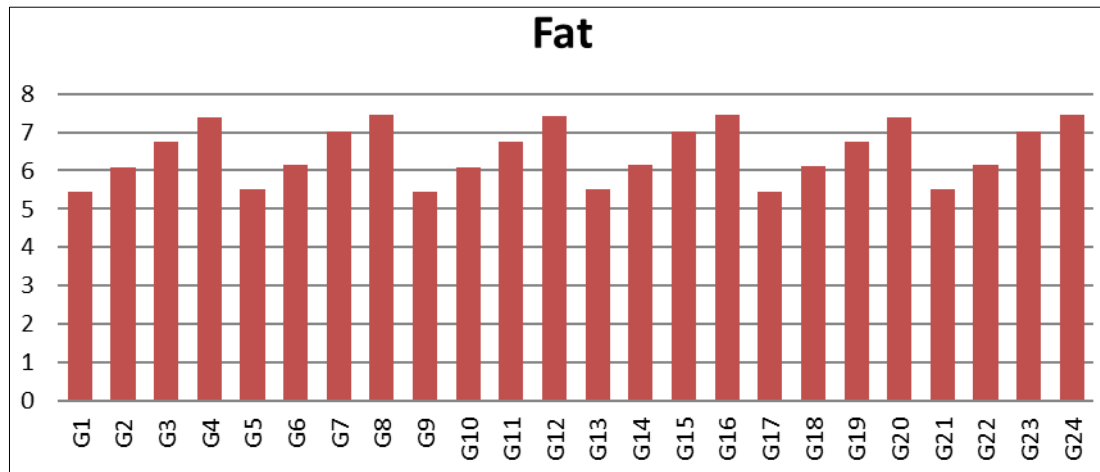


Fig 4: Average fat content of sugar free gulabjamun by using low calorie sweetener

Protein

Effect of different treatment combination, packaging material and different low calorie sweeteners on protein of sugar free Gulabjamun.

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 8.41, 8.09, 7.77 and 7.45 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 8.45, 8.13, 7.81 and 7.49 at 15 days interval.
- The treatment combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 8.41, 8.08, 7.77 and 7.45 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean

value (0 to 60 days) respectively 8.45, 8.12, 7.80 and 7.49 at 15 days interval.

- The treatment combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 8.41, 8.09, 7.77 and 7.44 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 8.45, 8.13, 8.7.81 and 7.49 at 15 days interval.
- The treatment combination that has low Protein content is 7.41 and higher is 8.45. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

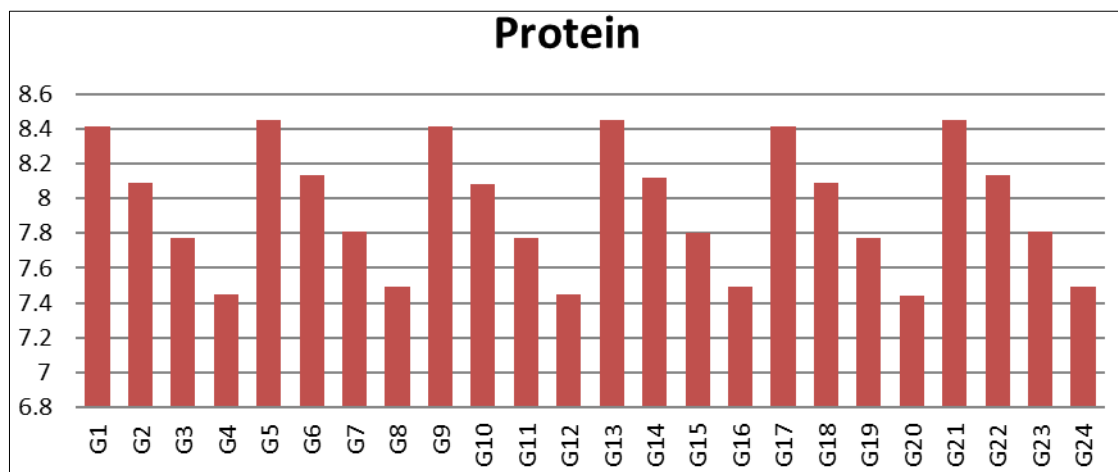


Fig 5: Average protein content of sugar free gulabjamun by using low calorie sweetener

Acidity (Lactic acid)

Effect of different treatment combination, packaging material and different low calorie sweeteners on acidity of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days

interval

- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days interval.
- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have

mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 0.514, 0.494, 0.454 and 0.424 at 15 days interval.

- The treatments combination that has low Acidity content is 0.424 and higher is 0.514. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

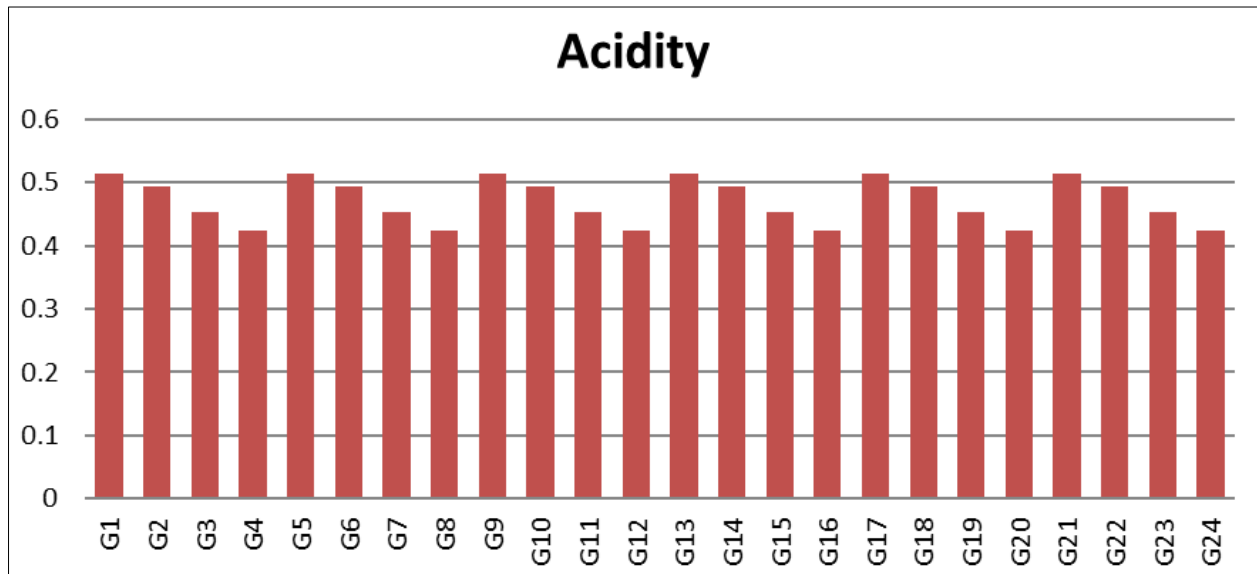


Fig 6: Average acidity content of sugar free gulabjamun by using low calorie sweetener

Carbohydrates

Effect of different treatment combination, packaging material and different low calorie sweeteners on carbohydrates of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 50.10, 49.95, 49.77 and 49.59 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 49.91, 49.76, 49.38 and 49.40 at 15 days interval
- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 50.09, 49.94, 49.75 and 49.58 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and

PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean value (0 to 60 days) respective 49.90, 49.76, 49.39 and 49.39 at 15 days interval.

- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 50.09, 49.93, 49.77 and 49.58 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 49.91, 49.76, 49.39 and 49.39 at 15 days interval.
- The treatments combination that has low Carbohydrates content is 49.38 and higher is 50.09. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

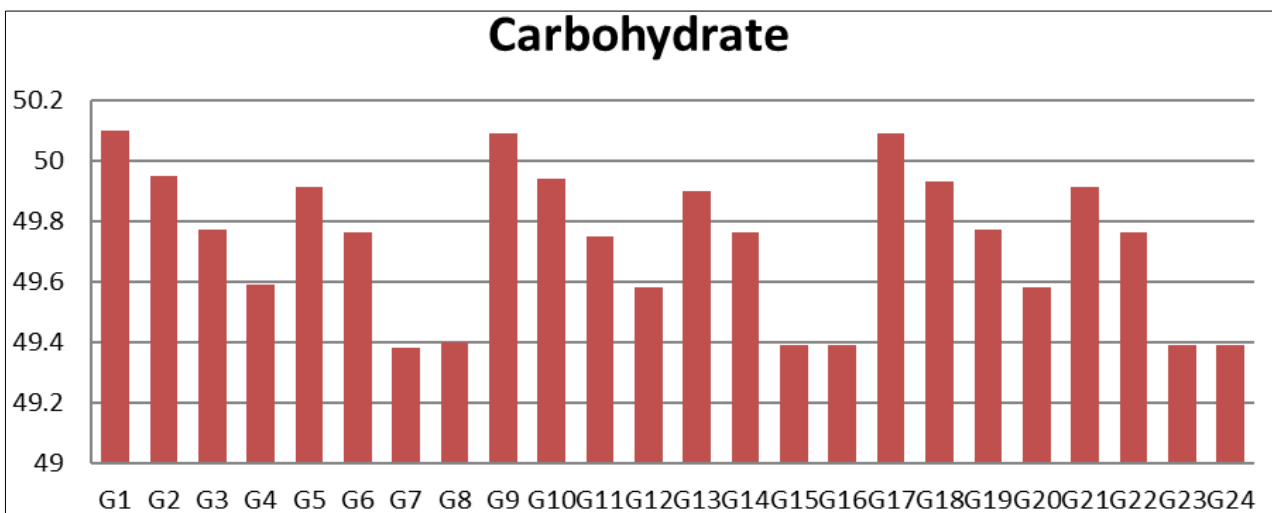


Fig 7: Average carbohydrates content of sugar free gulabjamun by using low calorie sweetener

Energy

Effect of different treatment combination, packaging material and different low calorie sweeteners on energy of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 292.23, 296.27, 300.22 and 304.15 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 292.25, 296.31, 301.27 and 304.16 at 15 days interval
- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 292.22, 296.24, 300.18 and 304.15 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and

PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean value (0 to 60 days) respectively 292.26, 296.32, 301.25 and 304.19 at 15 days interval.

- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 292.24, 296.29, 300.22 and 304.16 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 292.26, 296.30, 301.30 and 304.14 at 15 days interval.
- The treatments combination that has low Energy content is 292.22 and higher is 304.19. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

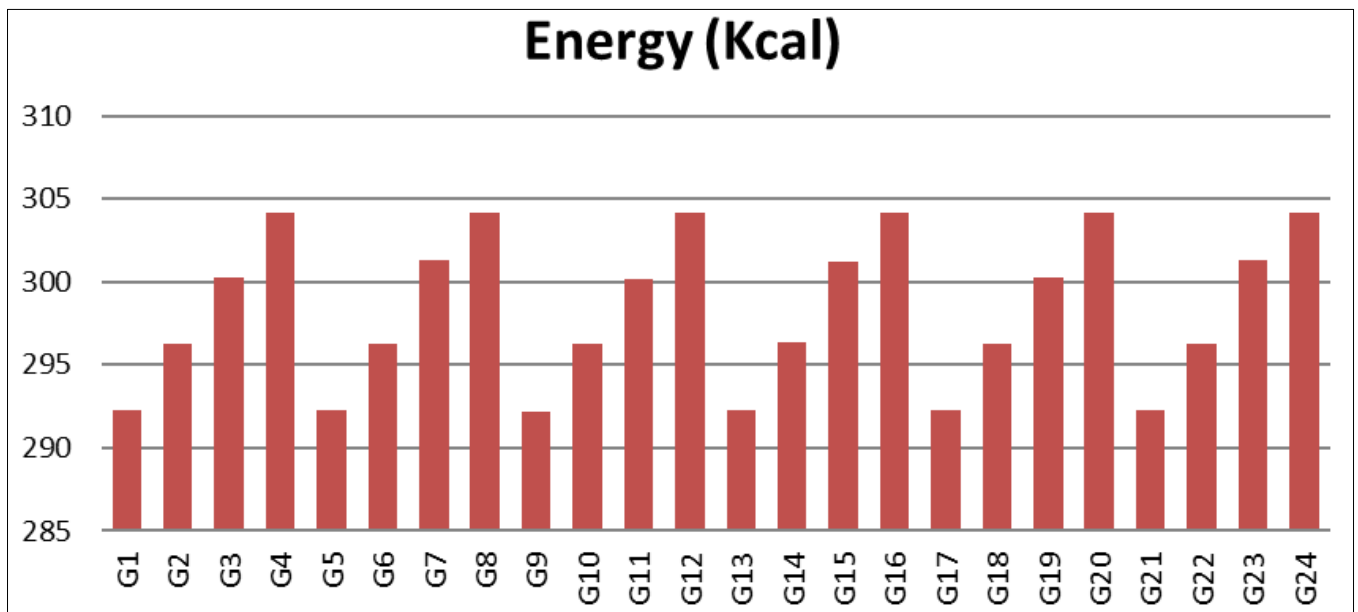


Fig 8: Average energy content of sugar free gulabjamun by using low calorie sweetener

ASH

Effect of different treatment combination, packaging material and different low calorie sweeteners on ash of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 1.56, 1.44, 1.35 and 1.26 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 1.60, 1.48, 1.39 and 1.30 at 15 days interval
- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 1.56, 1.45, 1.36 and 1.26 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean

value (0 to 60 days) respectively 1.60, 1.48, 1.40 and 1.30 at 15 days interval.

- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 1.56, 1.45, 1.35 and 1.27 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 1.60, 1.49, 1.39 and 1.31 at 15 days interval.
- The treatments combination that has low Ash content is 1.26 and higher is 1.60. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations

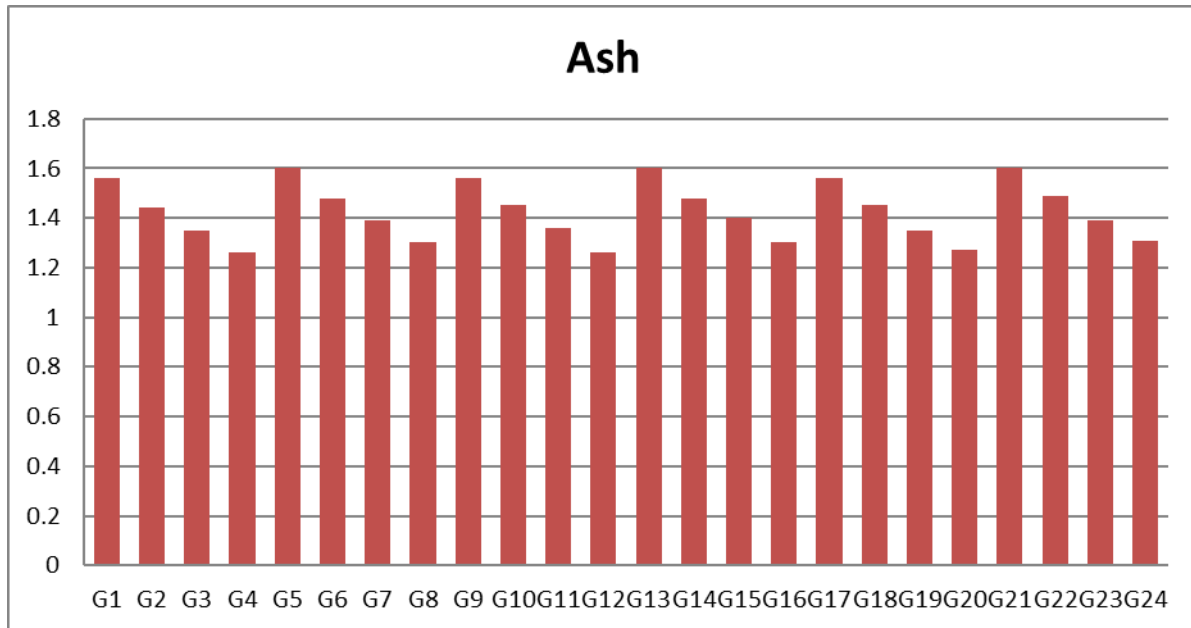


Fig 9: Average Ash content of sugar free gulabjamun by using low calorie sweetener

Total sugar

Effect of different treatment combination, packaging material and different low calorie sweeteners on total sugar of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 19.58, 19.52, 19.42 and 19.39 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 19.58, 19.52, 19.42 and 19.39 at 15 days interval.
- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 23.76, 23.70, 23.64 and 23.50 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean

value (0 to 60 days) respective 23.76, 23.70, 23.64 and 23.50 at 15 days interval.

- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 55.11, 55.06, 55.01 and 54.94 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 55.11, 55.06, 55.01 and 54.94 at 15 days interval.
- The treatments combination that has low Total sugar content is 19.39 and higher is 55.11. There are non-significant difference ($P < 0.05$) between different treatment combinations, different packaging material, and there is non-significant difference ($P < 0.05$) between different treatment combinations, and there is significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar) combinations.

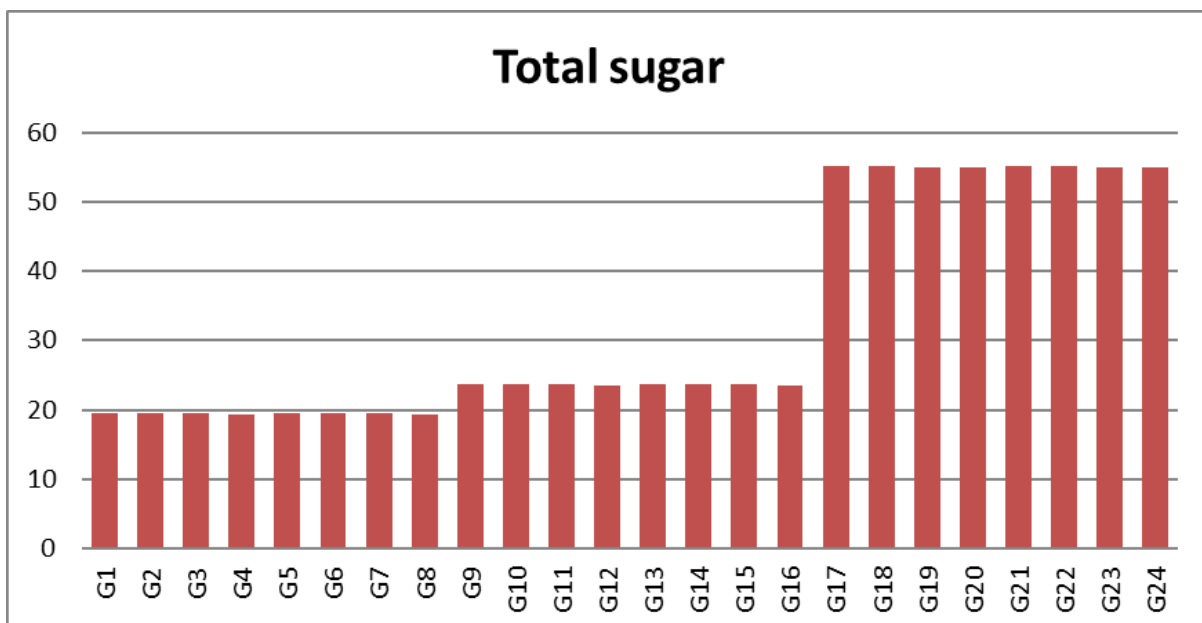


Fig 10: Average Total sugar content of sugar free gulabjamun by using low calorie sweetener

Total soluble solids

Effect of different treatment combination, packaging material and different low calorie sweeteners on total soluble solids of sugar free Gulabjamun

- The treatment combination of sugar free Gulabjamun (Stevia and LDPE) i.e. G₁, G₂, G₃ and G₄ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval. The treatment combination of sugar free Gulabjamun (Stevia and PE/ALFOIL/PE) i.e. G₅, G₆, G₇ and G₈ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval.
- The treatments combinations of sugar free Gulabjamun (Sucralose and LDPE) i.e. G₉, G₁₀, G₁₁ and G₁₂ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval. The treatment combination of sugar free Gulabjamun (Sucralose and

PE/ALFOIL/PE) i.e. G₁₃, G₁₄, G₁₅ and G₁₆ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval.

- The treatments combinations of sugar free Gulabjamun (Herbal sugar and LDPE) i.e. G₁₇, G₁₈, G₁₉ and G₂₀ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval. The treatment combination of sugar free Gulabjamun (Herbal sugar and PE/ALFOIL/PE) i.e. G₂₁, G₂₂, G₂₃ and G₂₄ have mean value (0 to 60 days) respectively 61.42, 61.50, 61.60 and 61.70 at 15 days interval.
- The treatments combination that has low T.S.S. is 61.42 and higher is 61.70. There are non-significant difference ($P < 0.05$) between different sugar (Stevia, sucralose and herbal sugar), different packaging material, and there is significant difference ($P < 0.05$) between different treatment combinations.

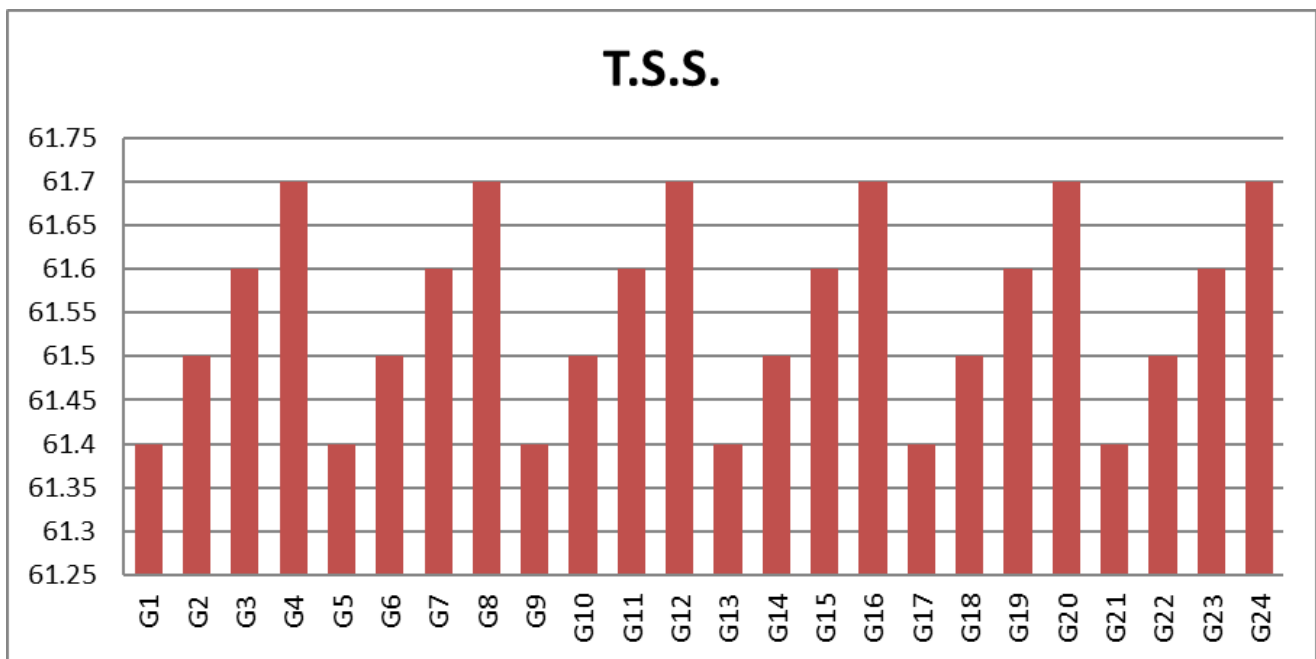


Fig 11: Average T.S.S. of sugar free gulabjamun by using low calorie sweetener

Conclusion

The Products (gulabjamun mix) packed was LDPE and aluminium foil for 15 day interval (0-60 days) and make the gulabjamun ball and dip low calorie sugar syrup. the basis of chemical analysis, the sugar free Gulabjamun in treatment G₁, G₅, G₈, G₁₂, G₁₆, G₂₀, (53:15:12:18:2) showed different value for moisture, fat, protein, acidity, carbohydrate, energy, ash, total sugar and total soluble solids. Result findings also revealed that out of three different levels of sugar used, almost equal results and were superior to Stevia, Sucralose and Herbal sugar. Result findings also revealed that different levels of packing with LDPE and aluminium foil of Packaging materials were used, almost also equal results were LDPE and aluminium foil packaging level.

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