Process optimisation for the development of giloy (Tinospora cordifolia L.) juice incorporated amla pulp candy

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Abstract

The juice extracted from the giloy (Tinospora cordifolia L.) stem was incorporated with the pulp of amla (Embilica officinalis Gaertn.) for the preparation of value-added nutritive candy. The process optimization was carried out for the prepared amla- giloy (AG) candy using the 'one factor at a time' (OFAT) method. Different concentrations of giloy juice (24ml, 48ml, 60ml, 72ml, and 96ml) were mixed with amla pulp for the development of candy and named AG-1, AG-2, AG-3, AG-4, and AG-5, respectively. AG-3 candy(1:1) with 60ml giloy juice and 60ml amla pulp was selected as the best candy for consumption which is rich in ascorbic acid (186.84mg/100g), β-carotene (166.120µg/100g), free radical inhibition rate (23.42%), total phenol content (55.472mg GAE/100g) and showed no growth of microbes in it. The selected AG candy is accepted with respect to the taste, color, and mouthfeel with overall sensory acceptability of 7.53 on the 9-point hedonic scale.

1. Introduction

Yellowish green fruits of *Phyllanthus embilica* L. or *Embilica officinalis* Gaertn. (also known as Indian Gooseberry or *Amla)* have medicinal and curative properties and its extracts are efficiently used in Ayurveda, and modern medicines. It is a rich source of ascorbic acid which is 160 times greater than apple [10] and 6 times greater than citrus fruits [18]. Amla fruits are also rich in flavonoids (kaempferol, & quercetin), tannins (Emblicanin A & Emblicanin B) and phyllemblin [21]. The curative and medicinal properties of amla include anti- cancerous activities [8], anti-depressant activity [13], cardioprotective effect [40], oral health [16], hair growth stimulator [32], and antihyperlipidemic activity [22].

Brownish green stem of *Tinospora cordifolia* (also known as *Giloy*, *Guduchi, Gurach* & *Amrita*) is also a major medicinal plant material used in Ayurveda *rasayanas* and old folk medicines. Lactones and diterpenoids present in giloy causes the bitter taste of its extract and juices [49]. Presence of several phytochemicals such as terpenoids, saponins, cardiac glycosides, and phenolic compounds increases its medicinal and curative properties such as neurotherapeutic activity [45], immunomodulatory effect [4], anti- diabetic effect [48], Metastasis inhibitory action [30], wound healing effect [48], anti- pyretic and anti- inflammatory activity [19].

Candy is defined as an unrestricted food made from sugar syrup or paste with the enrichment of pulp, and flavourings where milk and chocolates may or may not be added. Fruits that are candied are impregnated or coated with a layer of sugar syrup [15, 53]. Candying is also a method of preservation and improved storage stability. The history of fruit and vegetable preservations shows that during Egyptian civilisations, candying of fruits and vegetables were practised using a combination of honey, nuts and pieces of fruits or vegetables. Later on, in the 16th century in Germany, the modern method of candying was first practised. They preserved the fruits and vegetables or its peels as whole or in pieces dipped in sugar syrups. The industrial level of candy manufacturing was started at early 19th century [6, 52].

Grapes, pineapples, apples, cherries, strawberry, ginger, carrot, pumpkin, papaya, orange, lemon, mandarin, mangoes, gooseberry, and watermelon are some of the common fruits and vegetables being candied. Many researchers have undergone studies on different types of candies such as amla candy [1, 24, 50], carrot candy [14, 44], ginger candy [2, 28–29], pumpkin candy [11, 36], pineapple candy [9, 23, 25], citrus candy [17, 33, 42] and mango candy [26, 31, 38]. The incorporation of giloy juice or extract will increase the functional and therapeutic quality of all the above candies. Presence of magnoflorine, berberine, tinosporine, cordifolide and aporphin alkaloids makes giloy more healthy and medicinal plant compared to other ayurvedic plants [12]. But no studies shows the incorporation of giloy into any of the candies due to bitter taste of giloy.

The objective of the current research is the development of amla candy with addition of different ratios of giloy stem juice and to evaluate and compare the changes in proximate, functional and microbial quality of the candy.

2. Materials And Methods

2.1 Selection of raw materials

Fresh amla fruits were collected from the local market of Phagwara, Punjab. Fruits were washed and sorted out for the further procedures. Fresh giloy stem was collected from the medicinal garden of Lovely Professional University. Table salt (NaCl), sulphurous acid (equivalent to 2000ppm sulphur dioxide), cane sugar ($C_{12}H_{22}O_{11}$) were provided by the Lovely Professional University, Punjab, India.

2.2 Preparation of giloy juice incorporated amla candy

The process flowchart for the preparation of amla giloy candy is shown in Fig. 1. Sorted and selected amla fruits were blanched for 15 minutes using 15% table salt and sulphurous acid (equivalent to 2000ppm sulphur dioxide) and steeped for 12 minutes in cold water [51]. The blanched fruits were segmented out and the seeds were removed. The pulp of amla fruit was extracted out. The giloy stem was washed and cut into small pieces (almost 1cm×1cm size) for the extraction of juice. 300g of cut pieces were dipped in 100ml distilled water for soaking for 1 hour. The soaked giloy stem pieces were grinded along with distilled water and the crude content was filtered using muslin cloth. The obtained filtrate was again filtered using Grade 42 Whatman filter paper (2.5µm pore size) for the removal of extraneous materials [49].

Giloy juice was added at 5 different giloy concentrations such as 96ml giloy juice with 24ml amla pulp (4:1), 72ml giloy juice with 48ml amla pulp (3:2), 60ml giloy juice with 60ml amla pulp (1:1), 48ml giloy juice with 72ml amla pulp (3:2) and 24ml giloy juice with 96ml amla pulp (1:4) for the preparation of amla- giloy (AG) candy. Each concentration of amla- giloy candy were termed as AG-1 (4:1), AG-2 (3:2), AG-3 (1:1), AG-4 (2:3), and AG-5 (1:4) respectively (Table 1). The mixture of amla pulp and giloy juice were heated with the addition of cane sugar till the total soluble solid reached 50°B. 0.1% citric acid was added at 50°B and again heated till the brix reaches 75°B with a thick consistency. It was poured into the mould for desired shapes as shown in the Fig. 2 and kept in tray drier at 72°C for 24 hours. The dried candy in the mould is then kept in refrigerator at 4°C for 24hours.

Table 1
giloy: amla ratio and concentration of giloy used in candy

Coding	AG-1	AG-2	AG-3	AG-4	AG-5
Giloy: amla ratio	4:1	3:2	1:1	2:3	1:4
Giloy concentration (ml)	96ml	72ml	60ml	48ml	24ml

2.3 Estimation of proximate analysis of candy

Proximate and physicochemical analysis of candy with different concentration of giloy juice were measured. Moisture content, ash, titratable acidity, fat, crude fibre, total sugar, and reducing sugar were expressed in percentage (%). B- carotene was expressed in µg/100g of sample. All these proximate physicochemical parameter were estimated using the methods adopted from [39]. The proximate calculations were as follows;

$$MoistureContent(\%) = \frac{(weightofsamplebeforedrying(g) - weightofsampleafterdrying(g)) \times 100}{weightofsamplebeforedrying(g)}$$

1

$$TotalAshondrybasis(\%) = \frac{(Weightofdishwithash(g) - weightofemptydish(g)) \times 100}{Weightofdishwithdriedsample(g) - weightofemptydish(g)}$$

2

$$Titratableacidity(\%) = \frac{TitreValue \times Normalityofalkali \times Volumemadeup \times Eq.\ wt.\ ofacid \times 100}{Volumeofsampletakenforestimation \times Wt.\ ofsampletaken \times 1000}$$

3

$$Fatcontent(\%) = \frac{weightofoilextracted \times 100}{Weightofsampletaken}$$

4

$$CrudeFibre\%bywt = \frac{(weightofcrucible\&samplebeforeashing - weightofcrucible\&sampleafterashing) \times 100}{weightofdriedsampleused}$$

5

$$Reducingsugar(\%) = \frac{mgofinvertsugar \times dilution \times 100}{titre \times Wt.\ ofsample \times 100}$$

6

$$Totalinvertsugar(\%) = (equationsameasmentionedinthe\%reducingsugar)$$

7

$$Sucrose(\%) = (\%totalinvertsugar - \%reducingsugar) \times 0.95$$

8

$$Totalsugar(\%) = \%reducingsugar + \%sucrose$$

9

$$\beta - carotene(\mu g100g) = \frac{Opticaldensity \times 13.9 \times 10^4 \times 100}{weightofsample}$$

10

Total soluble solids were estimated using a hand refractometer and was expressed as degree brix (°B) [35].

Ascorbic acid or vitamin C was estimated using volumetric titration as per the method of [46] with L- ascorbic acid as standard. It is expressed in mg/100g of sample. Vitamin C was calculated as follows;

$$Ascorbicacid(mg100g) = \frac{0.5mg \times titrevalueofsample \times 100ml \times 100}{Titrevalueofstandard \times 5ml \times wt.ofsample}$$

10

2.4 Estimation of functional analysis of candy

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical inhibition activity was estimated using UV-Visible spectrophotometer at an absorbance of 517nm [47]. It was expressed as percentage. The calculation was as follows;

$$DPPHInhibition\% = \frac{(Absorbanceofcontrol(DPPH) - Absorbanceofsample) \times 100}{Absorbanceofcontrol(DPPH)}$$

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Total phenol content was estimated using UV- Visible spectrophotometer at an absorbance of 675nm against the standard gallic acid and was expressed as mg GAE/100g [47].

2.5 Estimation of sensory attributes of candy

Sensory evaluation was carried out using 9- point hedonic scale [55] where 9 liking points such as Like Extremely, Like Very Much, Like Moderately, Like Slightly, either Like nor Dislike, Dislike Slightly, Dislike Moderately, Dislike Very Much, and Dislike Extremely were used. For the analysis, 10 panellists from an age group of 20–50 were selected. The selected panellist were given training for the sensory analysis and were selected from the research students and teaching staffs who have good knowledge in the sensory analysis. The sensory booth was well lit with fluorescent lighting and the temperature was maintained at 22 ± 3°C. The samples were distributed in a petri plate with 5 different codes to get an unbiased result. The attributes such as colour, taste, flavour and mouthfeel were considered, and an overall acceptability was also calculated.

2.6 Microbiological analysis of candy

5g sample was used for the analysis of total plate count. Sample was macerated using a sterile pestle and mortar and was mixed in 20ml brine solution. Different dilutions of sample such as 10^0, 10^{-1}, and 10^{-2} were taken. Pipette 1 ml of each dilution into appropriate petri plates and pour the prepared nutrient agar which is cooled to 40°C. Incubate it at 37°C for 24 h once the agar is solidified [7]. The total plate count is expressed as colony forming units (CFUs) and is calculated as,

$$NumberofCFUspermlofsample = \frac{Numberofcolonies \times dilutionfactor}{mlofsampleplated}$$

12

2.7 Statistical analysis of candy

Responses such as moisture content, total sugar, reducing sugar, ascorbic acid, β-carotene, DPPH, total phenolic content and overall sensory acceptance were considered for the statistical analysis of AG candy. First degree polynomial equation was established using the analysis of variance and the optimum concentration of giloy juice added in the amla candy is also figured out using Design Expert 13.0.5.0 software. R^2 and standard deviation were also calculated. The OFAT graph were plotted with each responses to the giloy concentration.

3. Results And Discussion

AG candy was prepared with five different concentrations of giloy juice added during the process. Various effects on different concentration of giloy juice in AG candies with its physicochemical, proximate, functional, microbial and sensory characteristics are mentioned and discussed in the following sections.

3.1 Effect of concentration on physicochemical and proximate analysis of candy

Proximate and physicochemical parameters of AG candy made with addition of different concentrations of giloy juice are discussed in the Table 2. Moisture content of AG candy were increasing with decrease in the giloy concentration. The lowest moisture content was present in AG-1, i.e., 2.678 ± 0.273% and the highest was present in AG-2 candy with 4.347 ± 0.46%. Total soluble solids (TSS) were maintained at 75°B except for AG- 1 whose TSS was 76 ± 0.816°B. Ash content was lowest in AG-1 (0.32 ± 0.035%) while highest was for AG-5 (1.14 ± 0.12%). AG-1 had the highest titratable acidity, i.e., 0.742 ± 0.017% while lowest was for AG-1 with a value of 0.576 ± 0.054%. Fat content was increasing with the decrease in giloy concentration of candy. Total sugar and reducing sugar were also increasing from AG-1 to AG-2 candies. The highest total sugar content was 48.68 ± 2.63% and highest reducing sugar was 30 ± 2.82%. Highest ascorbic acid content was present in the candy with a lower giloy concentration, i.e., 198 ± 2.16mg/100g of AG-5 candy sample. Lowest vitamin C was present in AG- 1 candy with higher giloy concentration, i.e., 175.5 ± 1.870mg/100g of sample. Meanwhile β-carotene was decreasing with decrease in giloy concentration. Higher β-carotene content was present in AG-1 with 186.5 ± 1.224 µg/100g sample and lowest in AG-5 with 144.6 ± 3.6 µg/100g sample.

Table 2
Proximate and physicochemical parameters of amla-giloy candy with different concentrations of giloy juice

Nutritional Parameters	Amla-giloy Candy				
	AG 1	AG 2	AG 3	AG 4	AG 5
Moisture (%)	2.678 ± 0.273	3.225 ± 0.56	3.676 ± 0.478	4.166 ± 1.026	4.347 ± 0.46
TSS (°B)	76 ± 0.816	75 ± 0.816	75 ± 0.816	75 ± 0.816	75 ± 0.816
Ash (%)	0.32 ± 0.035	0.57 ± 0.072	0.86 ± 0.043	1.03 ± 0.08	1.14 ± 0.12
Titratable acidity (%)	0.742 ± 0.017	0.678 ± 0.026	0.627 ± 0.052	0.60 ± 0.14	0.576 ± 0.054
Fat (%)	0.05 ± 0.021	0.09 ± 0.021	0.09 ± 0.008	0.14 ± 0.043	0.16 ± 0.043
Crude Fibre (%)	8.3 ± 0.355	7.4 ± 0.496	8.1 ± 0.941	7.0 ± 0.089	7.5 ± 0.408
Total sugar (%)	40.01 ± 1.008	41.79 ± 1.869	42.13 ± 1.47	44.35 ± 2.035	48.68 ± 2.63
Reducing sugar (%)	22.05 ± 0.155	23.43 ± 1.018	25.86 ± 0.84	26.78 ± 1.66	30 ± 2.82
Ascorbic acid (mg/100g)	175.5 ± 1.870	181.8 ± 1.395	186.3 ± 3.9	192.6 ± 2.046	198 ± 2.16
B-carotene (µg/100g)	186.5 ± 1.224	179.2 ± 2.438	167.8 ± 3.84	152.5 ± 7.359	144.6 ± 3.6
*Values shown here are mean of triplicates ± S.D					

The retention in the moisture content and fat present in candy with increase in giloy concentration is due to the effect of giloy on the improved shelf- life properties. Presence of giloy in certain products showed the reduction in moisture and fat and an improved shelf life [27]. Ascorbic acid is higher in amla fruits, so that the AG candy with lower concentration of giloy will have higher concentration of vitamin C. Research have also stated that β-carotene is present in higher concentration in giloy than amla, therefore AG candy with higher concentration of giloy will have presence of higher β-carotene [20, 37]. Apart from the sugar added into the candy, amla naturally have a higher amount of total and reducing sugar present in it [3]. This results in the increase in sugar content with the decrease in giloy concentration of AG candy.

3.2 Effect of concentration on functional and microbial analysis of candy

Functional and microbial parameters of AG candy made with addition of different concentrations of giloy juice are discussed in the Table 3 and Table 4, respectively. Antioxidant free radical scavenging activity is expressed in terms of DPPH percentage inhibition. AG-1 candy has higher inhibition percentage with 28.4 ± 3.769% and this reduces with the lower concentration of giloy. Therefore AG-5 only had an inhibition percentage of 18.5 ± 1.47%. Giloy is scientifically proven to have higher antioxidant activities than any other herbal plants [43, 54] and was also mentioned in the Ayurveda as “elixir of God”. SO, the increase in giloy concentration can deliberately affect the percentage inhibition of free radical scavengers.

Table 3
Functional parameters of amla-giloy candy with different concentrations of giloy juice

Functional	Amla-giloy candy				
Parameters	AG-1	AG-2	AG-3	AG-4	AG-5
DPPH (%)	28.4 ± 3.769	26.7 ± 1.283	23.7 ± 3.137	19.8 ± 0.58	18.5 ± 1.47
Total phenol content (mg GAE/100g)	57.83 ± 3.515	54.793 ± 1.07	56.504 ± 1.77	55.5 ± 1.08	57.83 ± 1.31
*Values shown here are mean of triplicates ± S.D					

Table 4
Microbial parameter of amla-giloy candy with different concentrations of giloy juice

Microbial	Amla-giloy candy				
Parameter	AG-1	AG-2	AG-3	AG-4	AG-5
Total Plate Count (CFU)	0	0	0	$2\times10^1 \pm 0.4\times10^1$	$8\times10^1 \pm 1.7\times10^1$
*Values shown here are mean of triplicates ± S.D					

Total phenol content of candy is not affected by the concentration of giloy. Both AG-1 and AG-5 candies had highest total phenol content of 57.83 ± 3.515 mg GAE/100g and 57.83 ± 1.31mg GAE/100g, respectively. The lowest phenol content was present in AG-2 candy with 54.793 ± 1.07mg GAE/100g. Presence of bacteria was counted using total plate count. The results showed that the bacterial growth was absent in AG-1, AG-2 and AG-3 candies while AG-4 has a bacterial growth of $2\times10^1 \pm 0.4\times10^1$ and AG-5 has a growth of $8\times10^1 \pm 1.7\times10^1$. Giloy has great effect on the inhibition of microbial growth due to the presence of certain polysaccharides and terpenes [5, 34]. Therefore with increase in giloy concentration of AG candies, the microbial growth were retarded.

3.3 Effect of concentration on sensory evaluation of candy

Sensory parameters of AG candy made with addition of different concentrations of giloy juice are discussed in the Table 5 and the graphical representation of same in Fig. 3. Sensory attributes such as colour, taste, flavour, mouthfeel, and overall acceptability were considered. AG-5 was dominating among the 5 different AG candies. Colour was appealing with a dark- yellow, glossy shade and the mean value obtained for colour of AG-5 was 8.15 ± 0.59. The lowest obtained was for AG-1 where the colour was as same as AG-5 but was not glossy in appearance and the average score obtained was 6.35 ± 0.50. Taste was best described for the AG-5 candy with a score of 8.8 ± 0.24 while lowest was for AG-1 with a score of 6.8 ± 0.45. Flavour of each candies resembled a shade of amla but was not much sour compared to regular amla candies. When compared between the AG candies, AG-5 is prominent with a score of 8.5 ± 0.38 while AG-1 has a lower score of 6.65 ± 0.45. Mouthfeel of candies showed a bit chewy but was not hard and more of jelly like mouthfeel. The score was higher for AG-5 with 8.8 ± 0.33 while lower for AG-1 with a score of 6.8 ± 0.33. Overall acceptability was higher for AG-5 with a score of 8.5 ± 0.37 since all the above factors favoured AG-5, while lowest was for AG-1 with a score of 6.65 ± 0.31.

Table 5
Sensory parameters of amla-giloy candy with different concentrations of giloy juice

Samples	Colour	Taste	Flavour	Mouthfeel	Overall acceptability
AG-1	6.35 ± 0.50	6.8 ± 0.45	6.65 ± 0.45	6.8 ± 0.33	6.65 ± 0.31
AG-2	6.45 ± 0.52	7.2 ± 0.4	6.2 ± 0.45	6.95 ± 0.47	6.7 ± 0.22
AG-3	7 ± 0.38	7.85 ± 0.50	7.25 ± 0.37	8.15 ± 0.22	7.6 ± 0.3
AG-4	7.65 ± 0.59	8.6 ± 0.37	8.2 ± 0.24	8.4 ± 0.43	8.2 ± 0.2
AG-5	8.15 ± 0.59	8.8 ± 0.24	8.5 ± 0.38	8.8 ± 0.33	8.5 ± 0.37
*Values shown here are mean values of 10 panellist ± S.D					

When compared to the studies on amla candies by [24] and [41], the AG candies can be considered as prominent in its quality, taste and mouthfeel even though giloy juice was incorporated in it. The bitterness of giloy was covered up by the flavour of amla and no aftertaste were present in the candy. Glossy appearance and dark- yellow colour with jelly like and chewy mouthfeel could increase the cravings towards candy.

3.4 Statistical optimisation and analysis of variance

The numerical optimisation was computed using the responses such as moisture content, total sugar, reducing sugar, ascorbic acid, β-carotene, DPPH, total phenolic content, and overall sensory acceptability of AG candies with the factors mentioned in Table 1. The first order linear model was used for the optimisation and analysis of variance since, only a single factor is considered for the optimisation criteria. Moisture content ($p \leq 0.0057$), total sugar ($p \leq 0.0051$), reducing sugar ($p \leq 0.0022$), ascorbic acid ($p \leq 0.001$), β-carotene ($p \leq 0.0067$), DPPH ($p \leq 0.0102$), and sensory acceptability ($p \leq 0.0208$) were significantly affected by the different concentrations of giloy juice while total phenol content ($p \leq 0.8881$) was not significantly affected by the change in concentrations of giloy juice. The adequate precision was also calculated to know the desirability of above responses when related to the factor, i.e., different concentrations of giloy juice added in AG candy. This also showed that except for the total phenol content, all the other responses were desirable. Table 6 represents the analysis of variance, fit statistics, and regression coefficient of first order linear model for the response variables used in numerical optimisation of giloy juice incorporated amla candy.

Table 6
Analysis of Variance (ANOVA), fit statistics and regression coefficient of first order linear model for the response variables used in numerical optimisation of giloy juice impregnated amla candy

Responses	df	F- value	p- value	Estimated coefficient	Adequate Precision
Moisture (%)	1	50.92	0.0057	3.92	15.1371
Total sugar (%)	1	194.79	0.0051	42.61	24.1336
Reducing sugar (%)	1	97.65	0.0022	25.62	20.9620
Ascorbic acid (mg/100g)	1	168.2	0.001	186.92	27.5118
B- carotene (µg/100g)	1	45.49	0.0067	166.12	14.308
DPPH radical inhibition (%)	1	33.66	0.0102	23.42	12.3068
Total phenol content (mg GAE/100g)	1	0.0253	0.8881	55.47	3.1197
Overall sensory acceptability (9-point scale)	1	19.99	0.0208	7.53	9.4855

The numerical optimisation of AG candy using Design Expert software showed that the optimum condition was addition of 60ml of giloy juice to the total 120ml mixture, i.e., 1:1 ratio of amla: giloy in the candy. The optimum condition and its responses are shown in the Table 7. The selected concentration of AG candy contains moisture content of 3.618%, total sugar of 42.606%, reducing sugar of 25.624%, ascorbic acid of 186.84mg/100g, β-carotene of 166.120µg/100g, DPPH inhibition rate of 23.42%, total phenol content of 55.472mg GAE/100g, overall sensory acceptability of 7.53 and the desirability of 1.000. Graphical representation of responses against the single factor is shown in the Fig. 4.

Table 7
Numerical optimisation of giloy juice impregnated amla candy using Design Expert 13.0.5.0

Run	Giloy (ml)	Moisture (%)	Total sugar (%)	Reducing sugar (%)	Ascorbic acid (mg/100g)	B-carotene (µg/100g)	DPPH (%)	Polyphenol content (mg GAE/100g)	Overall sensory	Desirability	
1	*24.000*	4.511	48.660	29.704	198.585	143.260	17.930	57.872	8.588	1.000	
2	*48.000*	3.916	44.231	26.984	190.755	158.500	21.590	55.762	7.883	1.000	
3	60.000	**3.618**	**42.606**	**25.624**	**186.840**	**166.120**	**23.420**	**55.472**	**7.530**	**1.000**	**Selected**
4	*72.000*	3.321	41.374	24.264	182.925	173.740	25.250	55.692	7.178	1.000	
5	*96.000*	2.726	40.089	21.544	175.095	188.980	28.910	57.659	6.473	1.000	

4. Conclusion

The herbal and nutritional giloy juice is successfully incorporated into the preparation of pulped amla candy. Even though the process of candy making is old but the incorporation of value- added herbal extracts will enhance the nutritional properties and will benefit a wide group of people. The results clearly shows that the candy is rich in ascorbic acid, β-carotene, antioxidant properties and total phenol content. The variation in the concentrations of giloy juice significantly affected the responses of moisture content, total sugar, reducing sugar, ascorbic acid, β-carotene, DPPH, and overall sensory acceptability. Numerical optimisation clearly states that the AG candy made from 60ml giloy juice and 60 ml amla candy, i.e., AG-3 candy (1:1) is the best among the 5 different giloy concentrated AG candies. The selected product was dark yellowish in colour with a chewy jelly like mouthfeel. The product developed is microbiologically safe and can be consumed by any age groups.

Declarations

Author Contributions

N.P developed the idea and concept of the research work. N.P conceptualized, analysed, investigated, developed tables and figures and wrote the Original draft. T.M supervised and validated the research work. Both the authors reviewed the manuscript.

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Conflict of Interest

Authors declare no conflict of interest.

Data Availability

Not applicable

Ethics approval

Authors declare that the research manuscript, figure or tables are not submitted or published in any other journal.

Consent to participate

Not applicable

Consent for publication

Not applicable

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Figures

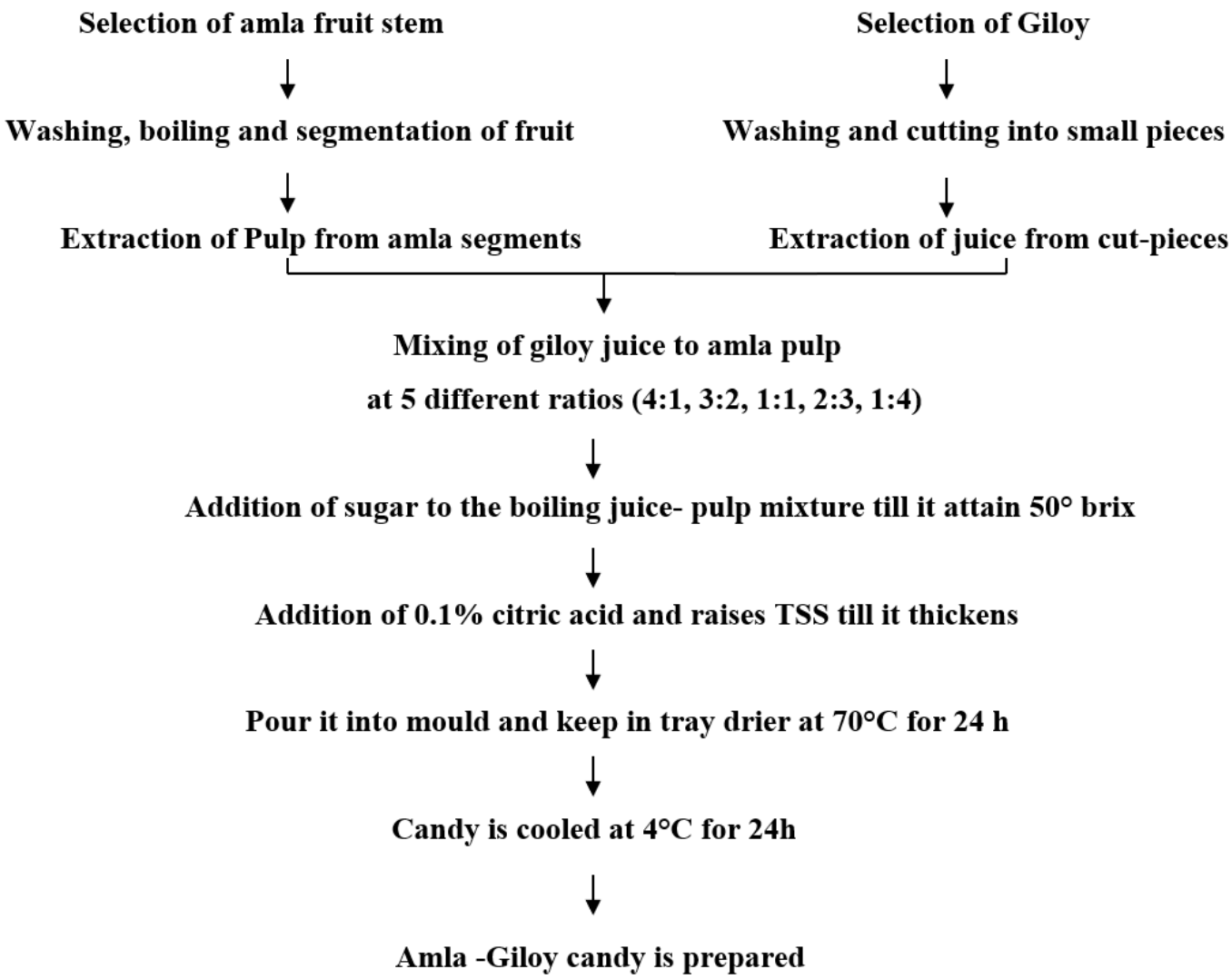

Figure 1

Flowchart on the preparation of amla- giloy candy

Figure 2

Giloy juice impregnated amla candy

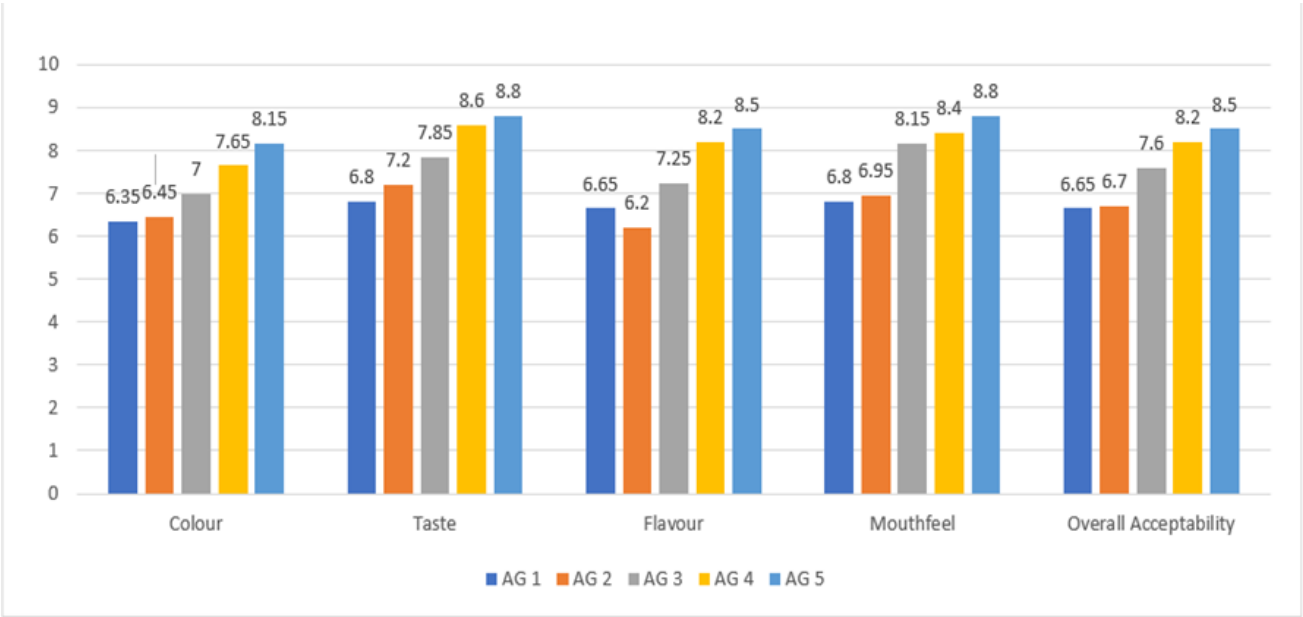

Figure 3

Graphical representation of the sensory attributes of amla-giloy candy

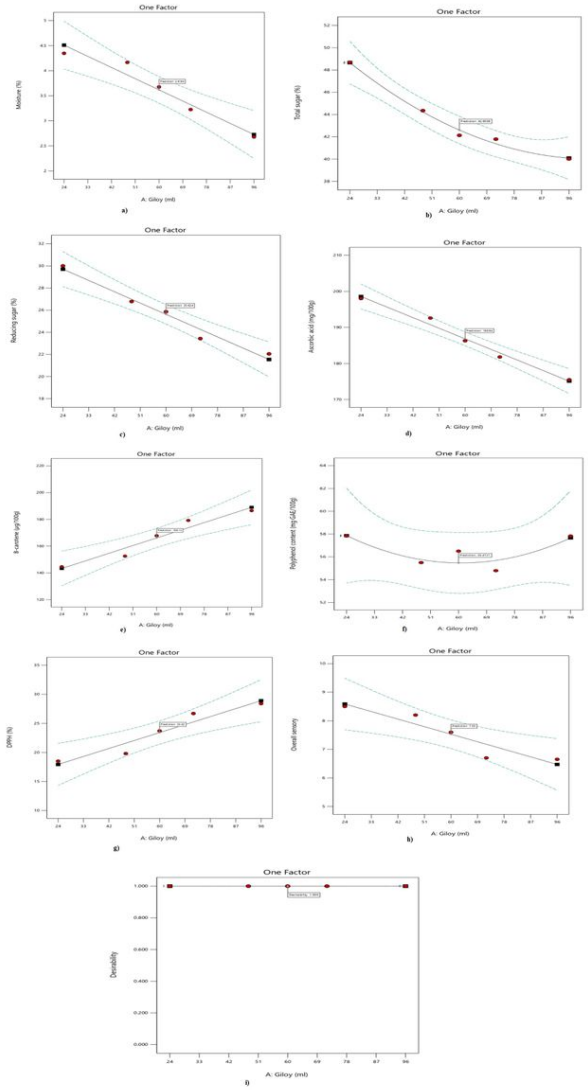

Figure 4

Single factor graphical representation of responses of giloy juice impregnated amla candy (a) moisture to different giloy concentration (b) total sugar to different giloy concentration (c) reducing sugar to different giloy concentration (d) ascorbic acid to different giloy concentration (e) β-carotene to different giloy concentration (f) total phenol content to different giloy concentration (g) DPPH to different giloy concentration (h) overall sensory acceptability to different giloy concentration (i) desirability to different giloy concentration