

Development and quality evaluation of an antioxidant-rich herbal ice pops

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Abstract—Ice popsicles (commonly known as ice pops) are one of the popular frozen desserts composed of fruit juices. Generally, ice pops are rich in sugar, artificial colour, flavour and have low nutritional values. The present study aimed in developing a herb infused healthy ice pops comprised of natural components. The major constituents of the developed product were kokum (*Garcinia indica*), lemon grass (*Cymbopogon citratus*) and peppermint (*Mentha piperita*). The aqueous extracts of the aforesaid natural sources were added in several proportions prior to freezing. The final composition of the product was selected on the basis of sensory analyses. Ice pops composed of kokum, lemongrass and peppermint extracts in the ratio of 8:1:1 had obtained the highest sensory scores among the other compositions and were subjected to further analyses. These herbal ice pops exhibited appreciable *in vitro* antioxidant potency (68% DPPH scavenging activity) owing to the presence of the natural constituents namely kokum, lemongrass and mint. Additionally, proximate analyses of the product revealed presence 0.46% protein, 28.94% carbohydrate and 52.33 Kcal/100g energy. Thus, kokum based herbal ice pop is a novel health beneficial frozen dessert rich in antioxidant property.

Keywords—Ice popsicles, kokum, antioxidant, herbal

I. INTRODUCTION

The traditional ice popsicles available in the market often come laden with excessive sugars, artificial colors and flavors, presenting a concern for health-conscious consumers [1]. Recognizing this gap in the market and the increasing demand for healthier alternatives, present study aims to develop a novel

herbal ice popsicle with appreciable antioxidant property.

This research paper aims to explore the unique proposition of creating ice popsicles infused with the natural goodness of kokum (*Garcinia indica*), lemongrass (*Cymbopogon citratus*) and mint (*Mentha piperita*) to offer a healthier and more flavorful alternative to traditional ice pops. While kokum is renowned for its tangy flavor and antioxidant properties, lemongrass adds a citrusy zing and is known for its refreshing aroma [2]. Lemongrass is also reportedly a rich source of flavonoids and phenolic compounds [3]. Mint, on the other hand, brings a cooling sensation and a burst of freshness. Additionally, it has antibacterial, antifungal, and antiviral properties [4]. It helps to promote the digestive system. Together, these ingredients not only provide a tantalizing taste experience but also offer a plethora of health benefits.

One noticeable aspect of this innovative product is its absence from the current Indian market scenario. Despite the popularity of ice popsicles, particularly during the summer season, there is a visible lack of options that prioritize health and natural ingredients. By introducing herbs-infused ice popsicles, this current study seeks to fill this gap and cater to the growing demand for nutritious yet delicious summer treats.

In the present study, kokum, lemongrass and mint-infused ice popsicles have been subjected to sensory analysis for its acceptance by the consumers. The sample with highest sensory scores has been further analysed for its nutritional composition. Owing to the reported antioxidant properties of kokum and lemongrass, the antioxidant efficacy has also been evaluated in this study. By elucidating the aforesaid parameters and nostalgic appeal of this innovative product, this

study envisages a promising avenue for redefining the ice popsicle industry in India.

A. Materials and methods

The quality of raw materials directly affects the quality of product and the price of raw materials affects the price of the product and profit directly [5]. Hence, proper selection and purchase of raw material is an important decision. Raw materials namely Kokum syrup was procured from Wholesale Shop at Ravivar Peth Pune, India. Peppermint and Lemongrass were procured from Bhaji Mandai at Loni Kalbhor Pune, India. Water is a main ingredient for the preparation of ice popsicles and to ensure good quality, RO treated water has been used in this study. DPPH and all other chemicals, solvents used in this work were procured from HiMedia Laboratories Pvt. Ltd., India.

Preparation of lemongrass and mint extract

In the pursuit of developing Kokum, Lemongrass, and Mint-infused ice popsicles, a rigorous methodology was employed to ensure the accurate preparation of the necessary extracts and final product. Initially, all ingredients were meticulously weighed using a precise weighing balance according to batch requirements. Following this, thorough cleaning of the peppermint and lemongrass was conducted to eliminate any extraneous matter, guaranteeing the purity of the extracts. Subsequently, RO water was added to separate cooking vessels, with mint leaves placed in one vessel and lemongrass in another. These vessels were then heated to temperatures ranging from 90-110°C for a duration of 15 minutes to facilitate the extraction process. Once boiled, the extracts were allowed to cool to room temperature naturally before being filtered through muslin cloth to remove any solid residues. The filtered extracts were then carefully collected in designated bottles for subsequent use in the ice popsicle preparation. The extraction of lemongrass and mint leaves was in accordance with the method reported by Okpo and Edeh [6].

Preliminary trials were conducted by varying the concentrations of lemongrass and mint extracts (Table I). Sample 2 was selected for the further processing in accordance with the sensory acceptability of the extracts.

TABLE I. Trials for Mint and Lemongrass Extract

	Lemon grass (g) +Water (ml)	Mint (g) +Water (ml)	Observation
Sample 1	10 + 250	10 + 250	Less flavor of both; More concentration Required
Sample 2	20 + 250	20 + 250	Strong flavor; acceptable for further use

Preparation of ice popsicles

The ice popsicles were prepared in accordance with the method described by Vijayalakshmi and Vijayavahini [7]. In the preparation of the ice popsicles, the ratio of Kokum syrup to RO water was established at 1:5 per batch. The diluted Kokum syrup underwent a sedimentation process for approximately 30 minutes to allow for the settling of suspended particles. Subsequent filtration of the sedimented Kokum liquid was conducted using a 4-layer muslin cloth to ensure clarity and purity. Pasteurization of the filtered Kokum liquid was then carried out at temperatures between 80-90°C for around 1 min to effectively eliminate potential pathogens. Following pasteurization, the Kokum liquid was rapidly cooled to room temperature to maintain freshness. Integration of the mint and lemongrass extracts with the diluted Kokum syrup was performed according to a predetermined formulation, aiming for optimal flavor balance. The final product mixture was then filled into designated packaging containers and securely sealed to prevent contamination. Storage of the ice popsicles at temperatures of 0°C or below ensured structural integrity and freshness, with consumption recommended upon ice formation.



Fig. 1. Herbal ice popsicles

Sensory analysis

The sensory analysis of different organoleptic characteristics i.e., colour and appearance, mouth feel, taste, flavour and overall acceptability were carried out by trained panellists. The average score was calculated for individual organoleptic properties. Sensory evaluation of developed ice pops was conducted by semi trained and trained panellists for various quality attributes (colour and appearance, texture, taste, flavour and overall acceptability) using 9-point Hedonic scale. Table 1 represents the sample formulations prior to sensory evaluation.

TABLE II. Sample Formulations

	Sample 1	Sample 2
Diluted Kokum Syrup	70%	80%
Lemongrass Extract	20%	10%
Mint Extract	10%	10%

Proximate Analysis of the ice popsicles

The sample ice popsicles with the highest sensory scores, was subjected to analyses of its proximate in terms of moisture, fat, protein and carbohydrate. The said parameters were evaluated in accordance with the standard methods [8].

Determination of moisture content

The determination of moisture content in samples involves the principle of heat-induced evaporation, leading to the loss of moisture, with the remaining dry matter representing the substance's quantity after moisture removal. This process requires an oven set to 105°C, Petri plates, and desiccators. The method involves washing dishes with detergent, drying them overnight in the oven, weighing them in a desiccator after cooling, and then weighing 5.0 g of sample into a dish. The sample is placed in the oven overnight, with periodic weighing until a constant weight loss is achieved. The moisture percentage is calculated using the formula

$$\% \text{ Moisture} = (W1 - W2) \times 100 / W1,$$

where W1 represents the initial weight of the sample and W2 the final weight.

Determination of fat content

The determination of fat content follows the principle of extracting ether-soluble components using petroleum ether in a Soxhlet apparatus. The method includes rinsing collection vessels and samples, weighing empty vessels, adding samples to thimbles, pouring solvent, and heating in the apparatus. After extraction, vessels are dried, weighed, and the fat percentage calculated using

$$\% \text{ Fat Content} = (W2 - W1) / W,$$

where W2 is the weight of the vessel with oil, W1 the weight of the empty vessel, and W the weight of the sample.

Determination of protein content

Protein content determination involves digesting samples with concentrated sulfuric acid, steam distilling, and titrating ammonia. Reagents include concentrated H₂SO₄, potassium sulfate, and standard HCl. The method requires heating the digestion system, filling tubes with samples and catalyst, adding H₂SO₄, and conducting the digestion process. Titration is performed with standard sodium hydroxide solution, and protein percentage is calculated using

$$\% \text{ Protein} = 0.625 \times \% \text{ N}_2.$$

$$\% \text{N}_2 = \frac{(87.5 \times \text{Normality of H}_2\text{SO}_4 \times \text{Titre value})}{\text{Weight of sample} \times 0.1}$$

Determination of carbohydrate content

Carbohydrate determination relies on the Anthrone reaction for identifying hexoses and aldopentoses. Equipment includes a water bath, centrifuge, and spectrophotometer, with materials such as test tubes and beakers. Reagents include hydrochloric acid and Anthrone reagent. The procedure involves hydrolysis, neutralization, centrifugation, analysis of supernatant, and preparation of standards. Absorbance is measured at 630nm, and carbohydrate content is calculated using a standard graph formula.

$$\text{Amount of CHO present (\%)} = [\text{Sugar value from graph} \times \text{Total vol. of extract} \times 100] / \text{Aliquot sample used} \times \text{weight of sample}$$

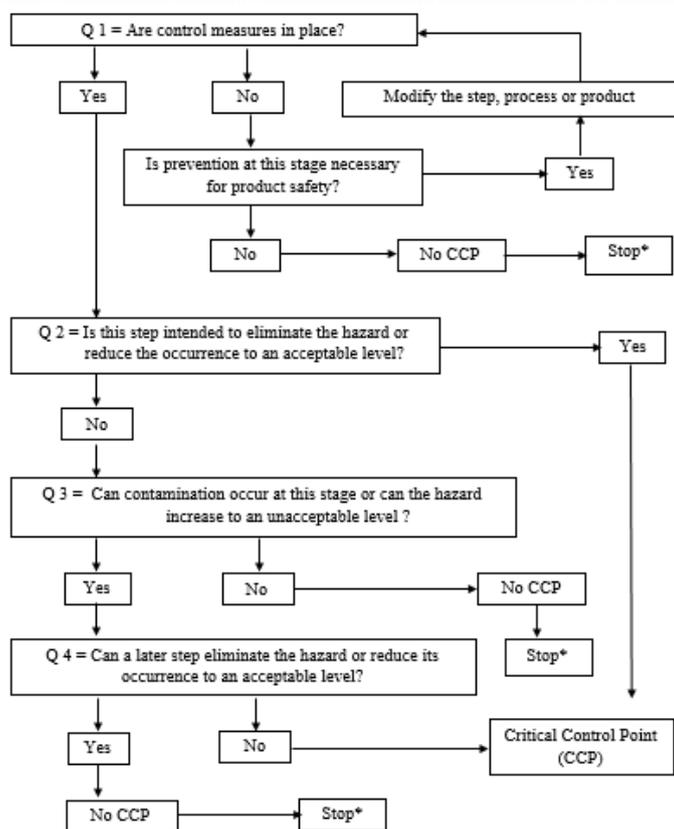
Determination of antioxidant properties of ice popsicles

The antioxidant property of the ice pops was evaluated in terms of DPPH radical scavenging activity. The 2,2-Diphenyl-1-picrylhydrazyl (DPPH) is a popular, quick, easy, and affordable approach for the measurement of antioxidant properties that includes the use of the free radicals used for assessing the potential of substances to serve as hydrogen providers or free-radical scavengers. The delocalisation on the DPPH molecule determines the occurrence of a purple colour, with an absorption band with a maximum around 520 nm. The analyses were conducted in accordance with the standard reported methods by Paul et al. [9]. Following formula has been used to calculate the % RSA;

$$\% \text{ RSA} = \frac{(\text{Absorbance of Control} - \text{Absorbance of Sample})}{\text{Absorbance of Control}} \times 100$$

Evaluation of quality control

Quality of the food may be defined as the composite of those characteristics that differentiate the individual unit of the product and have significance in determining the degree of acceptability of the unit by the consumer. Quality control in terms of Hazard Analysis and Critical Control Points (HACCP) is fundamental for



* The step is not a critical point. Proceed to the next step

ensuring food safety and maintaining product quality throughout the production process.

Fig. 2. CCP decision tree

The critical control points (CCP) in the process are identified in using the decision tree (Figure 2).

B. Results and Discussion

Sensory evaluation

In accordance with the sensory scores, sample 2 i.e. ice popsicles formulated with kokum syrup, lemon grass and min extract in the ratio 8:1:1 has been selected for further analyses. Figure 2 shows the sensory scores of two ice pop samples.

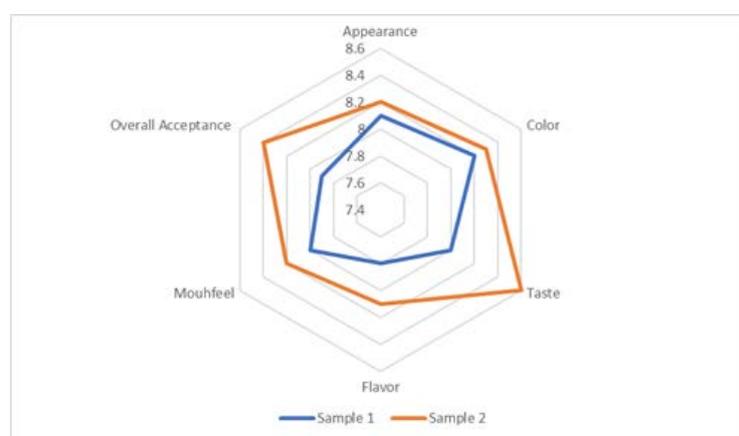


Fig. 3. Graphical representation for sensory evaluation of Ice pops

Antioxidant and proximate evaluation of the ice popsicles

The ice popsicles (sample 2) revealed presence of 0.46% protein, 28.94% carbohydrate and 52.33 Kcal/100g energy. Comprising 0.46% protein and 28.94% carbohydrate, they offer a glimpse into their macronutrient composition. Additionally, the energy content of 52.33 Kcal per 100g provides a measure of the caloric intake associated with consuming these icy treats.

The DPPH radical scavenging activity of the ice pops was evaluated to be 68% suggesting strong antioxidant (*in vitro*) potency. This finding underscores the presence of potent antioxidants within the ice popsicles, highlighting their potential health benefits beyond simple refreshment. Antioxidants play a crucial role in neutralizing harmful free radicals within the body, thereby mitigating oxidative stress and its associated health

risks [10]. While the *in vitro* assessment provides valuable insights into their antioxidant potency, extrapolating these findings to *in vivo* scenarios warrants further investigation. Moreover, understanding the specific antioxidants present in the ice popsicles could offer valuable clues regarding their origin and potential sources. By identifying these compounds, researchers could further elucidate the mechanisms underlying the health benefits associated with consuming these frozen treats.

Identification of CCPs

Critical Control Points (CCPs) in the production of ice pops play a crucial role in ensuring the safety and quality of the final product. Evaluating these CCPs is essential to identify potential hazards and implement appropriate control measures. Table II represents the CCPs considered in the development of the herbal ice popsicles.

TABLE II. CCP Monitoring and Verification System

CCP 1	Pasteurization
<i>Hazard</i>	Inadequate Time temperature combination
<i>Monitoring Method</i>	Thermometer
<i>Corrective action</i>	Reheat Batch 72 ⁰ C for 15 sec
<i>Verification</i>	Maintaining constant & Pasteurization temperature
CCP 3	Storage
<i>Hazard</i>	Improper Storage Conditions
<i>Monitoring Method</i>	Visual/Display Reading
<i>Corrective action</i>	Store product at 0 ⁰ C or Below
<i>Verification</i>	Maintaining constant temperature

Regular monitoring, verification, and validation of CCPs are essential to maintain process control and compliance with food safety regulations.

C. Conclusion

The herbal icepopsicles formulated with kokum syrup, lemongrass and mit extracts (8:1:1) was accepted well as per the sensory evaluation conducted on the same. The nutritional composition of the ice popsicles presents an

interesting association with their antioxidant properties. While carbohydrates provide the primary source of energy, the presence of antioxidants adds a layer of functional significance, potentially enhancing their appeal to health-conscious consumers. Balancing taste and nutritional value remains a persistent challenge for food manufacturers. The novel ice popsicles developed in the present study could the serve the purpose of a the functional food and could be investiaged further for its health benefits *in vivo* studies.

D. Abbreviations and Acronyms

DPPH- 2,2-Diphenyl-1-picrylhydrazyl
RO- Reverse Osmosis
HACCP- Hazard analysis and critical control points
CCP- Critical control point

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