

**Development of value added product from underutilized tuber and root**

**Dissertation-II Report**



**DEPARTMENT OF FOOD TECHNOLOGY AND NUTRITION**

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## CERTIFICATE

This is to certify that Krishna Kumar Shukla (**Registration No.11711412**) has personally completed M.Sc. Dissertation-II entitled, *“development of value added product from underutilized tuber and root”* under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of pre-dissertation has ever been submitted for any other purpose at any University. The project report is appropriate for the submission and the partial fulfilment of the conditions for the evaluation leading to the award of Master of Food Science and Technology.

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## **CHAPTER-1**

### **INTRODUCTION**

The carrot (*Daucus carota* L.) belongs to the family Apiaceae. Carrot usually sown in winter season in tropical regions and in summer season in temperate countries. It is one of the coolest season root vegetables and grown in many countries. Carrot provide components such as carotenoids vitamins B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub> and B<sub>12</sub> and minerals, and antioxidant compounds which are important for the development and functioning of the human body (Zielinska and Markovsk, 2010).

Origination of carrot is Asia. For its growth it requires less temperature due to this it is specific for the temperate climate. Its roots are long and thin, and of either purple or yellow in color. (Beceanu and Chiriac, 2007).

Studies have shown that it is rich in antioxidants properties. (Ambeden et al, 1971 and Alklint, 2003). It contains high level of functional compounds like carotenoids and dietary fibres.

Black carrot is a seasonal fruit and highly perishable due to this it is having less shelf life. Due to high content of phytochemical contents such as anthocyanin and phenolic content in black carrot it controls the risk of diseases in our body (Garba et al, 2014).

The garden carrot *Daucus carota* L., var. *sativus* Hoffm. can be divided into two cultivars: east-Asian and western. Roots of the western cultivar (*Daucus carota* ssp. *sativus* var. *Dativus* Alef.) are orange, yellow, red or white. The eastern cultivar (*Daucus carota* ssp. *sativus* var. *Atrorubens* Alef.) is characterized by red-purple or yellow colour of the root (Zadernowski, 2010).

### **Gummy confection**

Confection is a sweet and carbohydrate product which involve sucrose in which chocolates, nuts, fruits and vegetables or gums are used as optional. In 2014 it demands increase in business with annual growth rate of 2% during last five years. It reduces the calorific intake for diabetes patient and also to satisfy the appetite for sweet, and many sugars free are available in market. On the basis of all the studies fruits-based confection with low addition of sugar was not available. Confection is either no added sugar with health claim is not available (Savant, 2012 and Bali, 2007). Gummy confection or gummy candies are made

from hydrocolloid gels which influences the flavor and texture of candies. Substances like starch, gelatin and pectin forms the basic ingredient of hydrocolloid gels and these hydrocolloids reduce flavor release in foods (Zhang and Barringer,2017). These confectionary jellies comprises of good proportion of glucose and sucrose syrups along with gelling ingredients viz., pectin, starch and gelatin, and various food coloring and flavorings. Confectionary gels are characterized by soft and chewy structure which is owned to gelling agents used in its manufacturing (Delgado and Banon 2014). The various gelling agents used in manufacturing of gummy jellies influences its properties in various ways. Pectin is widely used in jelly confectionary and act as a barrier against flavor volatiles in food (Zhang and Barringer 2017). Starch is known to enhance the hardness of jellies (Delgado and Banon 2014) whereas, gelatin is known to be associated with gelling, thickening and stabilizing properties of gummy candies (Khairuddin et al., 2015).

Concentrated solution of starch, gelatine and sugar are used for the preparation of gumming jellies. Mixture of acid, flavour and raw product is gelatinized by cooking, followed by pouring of molten products into the moulds of different size and shapes. Gummy confection should have minimum 75% total soluble solid, to exclude mold growth (Burey et al., 2009).

To achieve consistent solid matrix after moulding of molten products, they are cooled and dried by air convection in tunnels. Type of the products jelly size, jelly composition are the factors which decide the drying conditions. Characterization of gummy jellies are they have firm structure with softness and also having chewiness which is due to the gelatine or pectin. (Burey et al, 2009)

Role of the ingredients in the preparation of gummy jellies are such as water helps in gel formation and acts as plasticizer, hardness of gelatine-based confections is due to starch co-solutes of sugars helps in rheological property of gels. Moisture helps in giving texture. As decreases the texture changes from soft to hard. Drying help in giving texture properties by reducing the moisture content and also increasing hardness. Confection is a group of carbohydrates rich products i.e. sugar or along with chocolate, nuts, fruits, vegetables or gummy.

## **COMPOSITION AND NUTRITIVE VALUE OF CARROT**

Carrot is considered as a source of vitamins B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, and B<sub>12</sub> and richest source of Beta-carotene. Carrot is highly nutritious and inexpensive vegetable. High carotenoid intake helps in lowering risk of many cancers especially the prostate cancer. Carrots are highly rich in vitamin A which act as an antioxidant and help in the growth and repair of the various tissues and also helps our body to fight against infection as well as skin disorders. (Singh et al., 2006)

<b>Parameter</b>	<b>Concentration</b>	<b>Reference</b>
Moisture	86%	Gopalan et al., 1991
Carbohydrate	10.6%	
Crude fibre	1.2%	
Protein	0.9%	
Fat	0.2%	
Total ash	1.1%	
Reducing sugar	1.67 -3.35%	Kaur et al., 1976
Non-reducing sugar	1.02 - 1.18%	
Anthocyanin	1,750mg/kg	Mazza and Minizte, 1993

### **Minerals**

<b>Minerals</b>	<b>Composition</b>	<b>Reference</b>
Ca	80 (mg/100g)	Gopalan et al., 1991
Fe	2.2(mg/100g)	
P	53 (mg/100g)	

## **FUNCTIONAL PROPERTIES**

Anthocyanin belong to family of flavonoids. Black carrot is having significant amount of anthocyanin in it. And it possess antioxidant capabilities and having free radical scavenging activity. Black carrot has high nutraceuticals value and high antioxidant activity (Elham and Shahrilar, 2013).

Table 1- Carotenoid content of black carrot (Total ppm) Grassmann et al., 2007

Carrot colour	Alfa-carotene	Beta-carotene	Lutein	Lycopene
Purple- orange	62-100	65	8-10	-

There is a large variation in the total anthocyanin concentration in the roots of black carrots. Total anthocyanin content dark black carrot was found to be 350mg/100g fresh weight (Kanmerer et al., 2004).

As black carrot rich in antioxidants such as vitamin-C and vitamin-E but it also has the presence of phenolics compounds which significantly contribute to the antioxidant capacity (Algarra et al., 2014). Anthocyanin gives purple color to carrot and carotenoids gives yellow, orange and red color to carrot (Sharma et al., 2011)

## **CHAPTER-2. REVIEW OF LITERATURE**

### **Carrot**

Carrot is important root vegetable which is rich in bioactive compounds such as carotenoids, dietary fibers and other functional components which possesses health benefits. It is an important source of natural antioxidants having anticancer activity. Carrot roots being traditionally used in salad and preparation of curries in India, and commercially utilised in the form of juice, concentrate, dried powder, canned, preserve, candy, pickle, and gazrailla. 50% of  $\beta$ -carotene is present in Carrot pomace could be utilized for the fortification of products like biscuits, cake, bread and also several types of functional products (Sharma et al., 2011).

Low yields is associated with carrot juice production around 50% of the raw material remains as pomace which is disposed as manure or as feed. It contains large amounts of valuable compounds such as neutral sugars, dietary fiber, carotenoids, uronic acids (Sharma et al., 2011).

Various products of carrots are manufactured by using several preservation and processing methods such as canning, dehydration, beverages, pickles and culinary products like halwa (Kalra et al., 1987) Ambadan and Jain (1997) better quality of products can be obtained by blending the dried carrot at 71<sup>0</sup> C for 3 to 6 minutes.

Blending of carrot or used as an ingredient for the preparation of juice is widely consumed in different parts of the world (Schieber et al., 2001)

50% of the carrot pomace which is the raw material obtained from the carrot juice industry is used as manure or feed. Carrot pomace contains significant number of carotenoids, dietary fibers (Nocolle et al., 2003). It also contains uronic acids and natural sugar (Stoll et al., 2003). Researchers are focusing to utilize the carrot pomace on a food products development such as preparation of high fiber biscuits (Kumari and Grewal, 2007)

Black carrot is rich in anthocyanin which is used as a natural colorant for confectionery products like jams, jellies and frozen desert (Briks, 1999). Purple carrots are rich in health promoting nutraceutical foods because of the presence of cyanidin based pigments. Similarly, black carrot is also promote nutraceutical properties (Alasalvar et al., 2001). It also helps in preventing health problems by adding anthocyanin sources such as cyanidin,



delphinidin and petunin.

Carrot pomace is basically a left-over product during juice preparation which is rich in fiber. All the fiber rich food products contain insoluble fiber-rich fractions which acts as a hypocholesterolemic functional ingredient (HSU et al., 2006). In dried carrot pomace content of ascorbic acid and  $\beta$ -carotene in the range of 13.53 to 22.95mg and 9.87 to 11.57 mg per 100g respectively (Upadhyay et al., 2008).

Purple or black carrot are considered as good source of natural food color, because due to higher consumer demand for the natural colors and also of the legal restrictions toward the use of artificial or synthetic food colors. Due to high levels of anthocyanin it gives an attractive bluish-purple color. It has high Ph and also having light and heat stability due to this property it can be used as a natural food colorant (Kirca *et al.*, 2006).

Carrot can't be picked by the help of lactic acid fermentation long term storage of carrot is possible and there is less changes in nutritional composition for at least 6 month in anaerobic condition, with the metabisulfite (Pruthi et al.,).

Kirca et al, (2006) studied the Anthocyanin stability of black carrots at various solid contents i.e. 11, 30, 45 and 64<sup>0</sup>Brix and pH from 4.3 to 6.0 during both heating, at 70 to 90<sup>0</sup>C, and storage at 4–37<sup>0</sup>C. They found that degradation of monomeric anthocyanins increased with increasing solid content during heating and it decreases during storage. They observed at pH 4.3, half-life periods for anthocyanins at 30, 45 and 64<sup>0</sup> Brix were respectively 8.4, 6.9 and 5.2 h during heating at 80 <sup>0</sup>C and 18.7, 30.8 and 35.9 weeks during storage at 20<sup>0</sup>C.

Kirca et al, (2006) also studied the effect of pH on thermal stability of anthocyanins at six different pH range from 2.5to 7.0 in citrate-phosphate buffer solutions and they found significant decrease in anthocyanin stability was observed at pH above 5.0. At 30–64<sup>0</sup> Brix. Its contain anthocyanin and anthocyanidins based compounds which are highly effective in increasing insulin released from pancreatic  $\beta$ -cells (Akhtar et al, 2017). Black carrots contain phytochemical such as anthocyanins, phenolic acids, carotenoids which helps in curing dyslipidaemia, glucose tolerance, insulin resistance and hypertension. Researcher proved in their studies that black carrot contains bioactive compounds which help in curing cardiovascular diseases (Akhtar et al, 2017).

**Table- Shows the Anthocyanin, Phenolic content, DPPH, FRAP of BLACK CARROT Variety (Purple haze)**

COMPONENT	Units	CONENTRATION	REFERENCE
Anthocyanin	(mg/100g)	1.5-126.4	Ersus and Yurdagel, 2017; Montilla et al., 2011; Algarra et al., 2013
Phenolic content	MgGAE/100g fw	17.9-492	Montilla et al, 2011; Algarra et al, 2013
DPPH	$\mu$ M TE/100g fw	240	Algarra et al, 2013
FRAP	$\mu$ M TE/100g fw	182	

### **Gummy confection**

Delado et. al., (2014) studied about the minimum drying time of gummy confections based on their mechanical properties and the subsequent strength required for handling. The raw materials which were used are gelatinized by different methods including cooking, colouring and flavouring and mixing with different acids and then they were moulded in different shapes and sizes. The liquid is prepared in the cooker extruder and all the raw materials are mixed in such that the final product should achieve at least 75%, total soluble solids to facilitate the growth of molds. In the present study four different confections contains different gelling agents such as starch and gelatine were formed in starch powder molds and dried at 21<sup>0</sup>c maintaining the Rh at 35% for 24 hr. using textural profile analysis the texture of the jellies was monitored along with the physical parameter including moisture, water activity, Ph soluble solid. It was found that the hardness, chewiness and gumminess were increased from 12 to 16 hrs and after that it is stabilized and this effect does not affect the cohesiveness and springiness. A modest correlation between data containing texture, dehydration and pH was found. Thus, it was calculated that textural profile analysis is useful tool for adjusting the drying time of gummy confectionary.

Hani et al., (2014) worked on gelatin and high-methoxyl pectin based gummy confections incorporated with 20-25% (w/w) red pitaya fruit puree prepared at various ratios of gelling

agent to water (gelatin:water 1:1, 1:1.5, 1:2), (pectin : water 1:1.5, 1:1.75, 1:10). This combination showed higher antioxidant activity with increase red papaya fruit puree content whereas hardness, gumminess and young's module decrease significantly sensory analysis showed that red papaya fruit puree could be used in making gummy candies with no adverse effect on the texture and overall acceptability.

Zhang and Barringer (2017) conducted the study on binding ability of hydrocolloid and additives in gummy candies for strawberry flavour volatiles. Different hydrocolloid such as gelatin, pectin and starch are used. The study shows that gelatin produced the lowest volatile concentration when compared to pectin or starch which were in not different from each other. The increase in concentration of pectin lead to decrease in volatile concentrations. Sugar had the greatest effect on volatile concentration in the headspace. Increasing sugar content from 0 to 55% caused the volatile release to drop significantly. However further increasing sugar from 55 to 74% produced either an increase or decrease, depending on the volatile pH 3.86 had the greatest volatile release for most volatile and decrease the pH 3.65 to 3.47 further decrease the headspace alone had no significant effect on flavour release.

Berey et al., (2008) investigated the role of different gelling agents. Gelling agents used in the manufacture of confectionary gels were agar, starch, pectin, alginates, and gums the majority of gels contains sucrose, glucose, syrup, starch, gelatin and water with minor components including foods acids, flavourings, and colourings. Sucrose was used in combination with glucose syrup. Glucose syrup helps enhancing the sucrose stability and prevent sucrose crystallization in the gummy candy. Sucrose also increased the bulkiness in the product, gels body and also contributed to the mouthfeel.

Khairuddin (2015), prepared the gummies from fish and beef gelatin with the addition of anthocyanin and colored by chokeberry and American elderberry. The pigment stability and color characteristic of anthocyanin in gummies prepared from beef and fish gelatin. Anthocyanin from gummies is extracted with the help of ethanol and anthocyanin concentration and stability is monitored weekly with the help of hunter color Quest Shimadu spectrophotometer. He observed that, there is decrease in the anthocyanin concentration in the fish gelatin gummy which is colored by chokeberry extract. When it is stored for 24 hrs in dark condition whereas beef gelatin gummy containing American elderberry extracts also showed decrease in anthocyanin content after 24 days of storage in dark conditions.

Jamun based confection was developed from a blend containing 26.585% paste of jamun pulp, 2% jamun seed powder, 2.2899% agar, 1.890% pectin, 27.236% polydextrose, citric acid. The confection prepared from jamun found to be good source of minerals, and also possess prebiotic activity has high dietary fibre, low glycemic index, and having dose dependent antioxidant effect and it also contain antimicrobials compounds. Whole jamun based confection also possessed antidiabetic property by suppressing  $\alpha$ -amylase activity (Sehwag et al., 2016).

Ajmadi et al., (2018) prepared gummy candy by encapsulating betalin in liposomal nanocarriers and they had observed that the antioxidant and betanin activity of the samples is twice than the normal candy containing free betanin. Introduction of liposomal nanoparticles helped in increasing the bioavailability of betanin

### **CHAPER 3. PROBLEM BACKGROUND**

Black carrot is an underutilized seasonal tuber and root crop which is highly perishable especially in fresh form. However it is unique owing to its phytochemical content particularly its anthocyanin and other phenolic acids that play important role in reducing the disease risk. Although extensive work has been done on red carrot but still work on value addition of black carrot is in its infancy. Major work is done on extraction of anthocyanin pigment from black carrot.

The present study is based on the utilization of black carrot into confectionary products in order to add value to the crop and also add to the commercial products basket

#### **Chapter 4. PROPOSED RESEARCH OBJECTIVES**

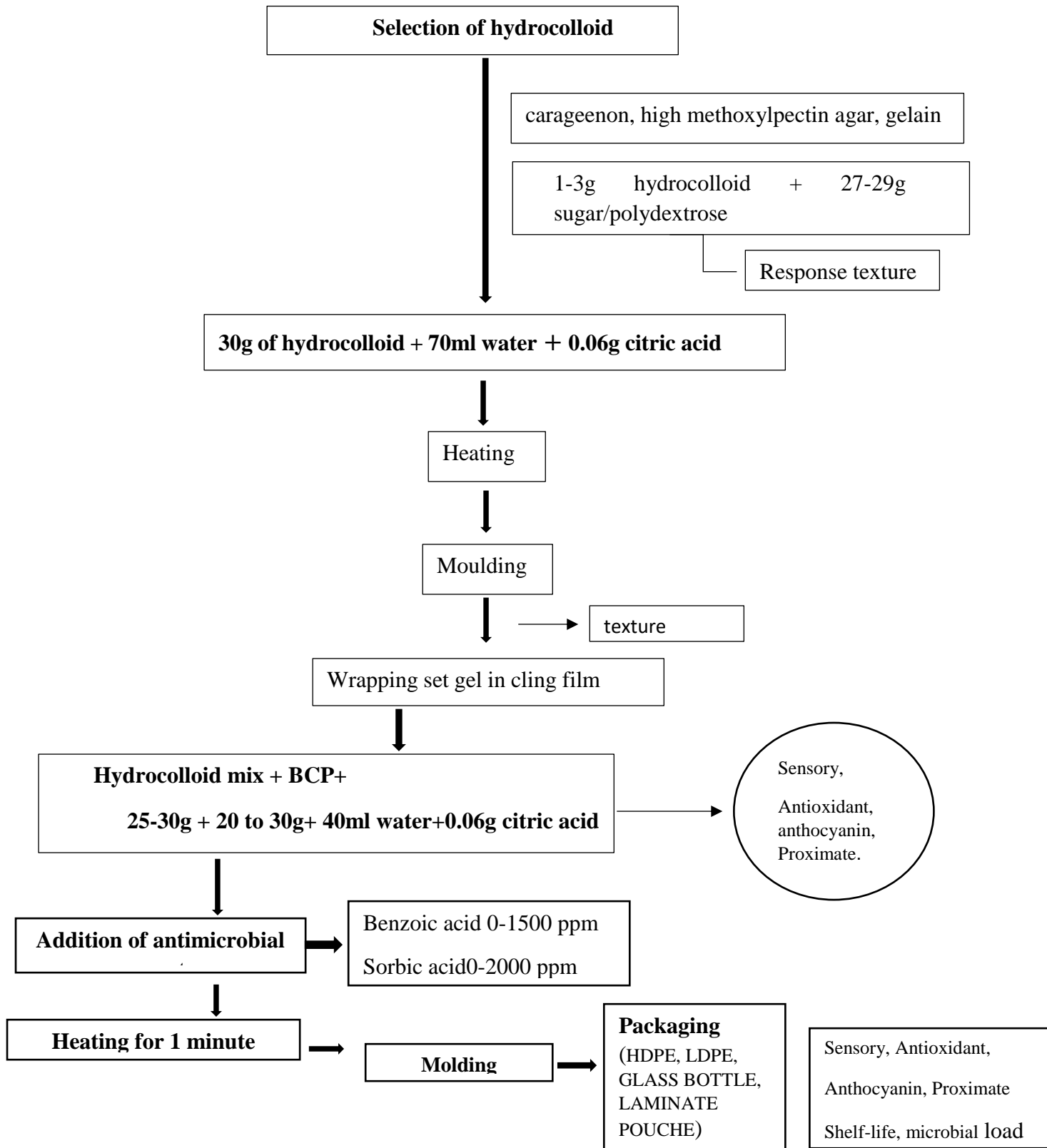
The proposed objectives of the present study are as under –

- 1) Optimization of the formulation of black carrot based gummy confection.
- 2) To select the antimicrobial agent for extension of shelf-life.
- 3) To select the packaging material for the optimized confection.

## Chapter 5. PROPOSED RESEARCH METHODOLOGY

### EXPERIMENT NO. 1: Optimization of formulation of black carrot confection.

#### 1.1 Optimization of hydrocolloid mixture.



## **1.2 optimization of confection formulation.**

Proximate and Phytochemicals Analysis (according to Ranganna ,2006)

Moisture Content

Protein content

Fat content

Crude fibre content

Ash content

Sugars

Dietary fibre content

Ascorbic Acid

Total polyphenols

Anthocyanin

Carotenoid



**EXPERIMENT NO.2-** Optimization of antimicrobial agent for extension of shelf-life

- Sodium benzoate

- Potassium sorbate

- TPC, YEAST & MOLD

**EXPERIMENT NO. 3-** Selection of packaging material (LDPE, HDPE)

Product stored for 2 months for shelf-life study.

Sample was analysed for proximate and functional properties at regular interval.

**Organoleptic Evaluation**

A 9-point hedonic scale will be used to evaluate the experimental samples using 25 semi-trained panellists. Healthy male and female of suitable age will be selected for the evaluation.

<b>Expression</b>	<b>Points to be assigned</b>
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

## ANALYSIS OF THE FINAL PRODUCT

**Chemical composition** according to Ranganna (1986)

### Proximate composition

- Moisture
- Ash
- Protein
- Carbohydrate
- Acidity<sup>0</sup> Brix
- Reducing sugar
- Dietary fibre
- Sensory analysis 9-point hedonic scale

### Functional properties-

- Anthocyanin
- Ascorbic acid
- Total phenol content
- Flavonoid content
- Antioxidant activity –
  - DPPH method
  - Reducing power

## **Chapter 6. EXPECTED RESEARCH OUTCOME**

The black carrot candy will be rich in anti-oxidant, anti-microbial. The black carrot candy will be having the properties to boost up the immunity and provide protective health benefits to the consumers. As the black carrot not only contains important phytochemicals, but also have the medicinal properties, thus the product which is made from its utilization will possess both functional as well as nutraceutical properties and will be of high value for the consumers. The finished product will be rich in antioxidants and other therapeutic properties. Also, it will be having the antibacterial, antimicrobial, insecticidal properties, thus the product made out of it will be resistant to insects and pests to some extent and will possess better shelf life. Our main aim is to standardize the Preparation of black candy by using different types of sugar syrups. Thus, the product will be beneficial for maintaining good health or for its nutritional benefits.

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