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FORMULATION AND ACCEPTABILITY OF CALCIUM FORTIFIED CITRUS FRUIT SQUASHES

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ABSTRACT

Calcium is a very important cation and a most common inorganic element of the human body. Inadequate calcium intake is a serious public health concern since this mineral is involved with numerous metabolic process including bone remodeling, vascular function, muscular contraction. Fortification is one approach for increasing the intake of a particular nutrient. Calcium fortified foods are an option for individuals who cannot meet their calcium needs from natural food sources. The purpose of food fortification is aimed in preventing or correcting a deficiency of micronutrients. Calcium fortification is currently receiving much attention in food industries. Substituting calcium fortificants in fruit drinks will increase the nutritional quality of processed foods and help to correct demonstrated dietary deficiencies. Hence the present study entitled "Formulation and acceptability of calcium fortified citrus squashes" was carried out with the following objectives that is formulation and standardization of standard and calcium fortified squashes using selected citrus fruits, physicochemical analysis of the standard and calcium fortified fruit squashes, organoleptic evaluation of standard and calcium fortified citrus fruit squashes and storage stability of standard and the selected calcium fortified squash**.**

Key Words: Calcium, Fortification, Citrus fruits, Calcium fortified citrus fruit squashes.

INTRODUCTION

India is an agricultural based country. By virtue of variable climatic and geographical conditions, different types of temperature, tropical and subtropical fruits and vegetables are consumed in fresh and only about 1.6% of total production of foods and vegetables is processed (Dhaliwal, 2004). India is the world's second largest producer of fruits and vegetables, but the industry itself is not fully developed. Value addition to food product is expected to increase from the current 8 percent to 35 percent by the end of 2025 (Ravindranath, 2005). Citrus fruit contain hundreds of nutrients including high levels of vitamin c and significant amounts of dietary fiber, beta carotene and other antioxidants and folic acid. They also have abundant phytochemical, which are believed to have a role in preventing a range of chronic health conditions including cancer and heart disease (Fleming *et al* 2003). Citrus fruits contain a high concentration of vitamin C which plays a main role in preventing colds (Johann, 2008).The kiwi fruit is the edible berry of a cultivar group of the woody vine, originally known as the Chinese goose berry.

Raw fruit is also rich in the protein dissolving enzyme actinidin which is commercially useful as a meat tenderizer. Kiwifruit promotes laxation in the elderly (Jane , 2004). Kiwifruit looks like a fuzzy brown egg, on the inside its bright green flesh is sprinkled with a ring of small, black seeds. It has distinctive, somewhat tart flavors. Kiwifruit provides about 80 mg of vitamin C and the fruits are richly endowed with phytochemical. Passion fruit juice is a good source of ascorbic acid. Passiflora edulis or passion fruit is strong and rich flavoured with a pleasant aroma (Reynhardt, 2003). Passion fruit are mostly used for squash making as they posses all the prerequisites for good quality squash, in terms of an optimum blend of acid, sugar and flavor (Kundan *et al* 2006). The grape fruit is a sub tropical citrus tree grown for its bitter fruit which was originally named the "forbidden fruit". These are a good source of vitamin C and especially high in pectin, a soluble fiber that helps lower blood cholesterol (Takeoka, 2001). Calcium plays an important role in the maintenance of health. It has been called the prime investigator of vital activity and it is required for proper fetal growth, for normal health of the mother during pregnancy and lactation and for the selection of breast milk. It speeds all the healing processes and controls the conduction mechanism and the nerve tissues (Johri, 2005).

Calcium citrate malate exhibits excellent bioavailability and this formulation is a useful addition to the forms of calcium now available either for direct supplementation or for food fortification (Springer, 2007). Adequate intake for calcium cannot be met with dairy free diets while meeting other nutrient recommendations. To meet the adequate intake of

calcium for calcium without large changes in dietary patterns, calcium fortified foods are needed (Tucker, 2002). An adequate calcium intake is essential to maintain calcium balance and build strong bones. The calcium rich sources include some vegetables, fortified foods and supplements (Florian, 2005). Acid solutions enhance the solubility of calcium salts. Much of the digestion of foods takes place in the duodenum where the pH of the gastric juices is low. Since calcium salts are more soluble in acid pH, much of the absorption of calcium takes place in this segment of the gastrointcestinal tract. Tricalcium phosphate, calcium citrate malate, calcium lactate, calcium carbonate have all been used as calcium source in various calcium fortified products. It is disclosed that calcium citrate malate is the preferred salt for calcium. Fortification involves the addition of nutrients to foods irrespective of whether or not the nutrients were originally present in the food. It is a means of improving the nutritional status of a population. Fortified foods make an important contribution of diets. Adding nutrients to foods is not a new idea but the types of food selected and the amounts of nutrients added will depend on the particular nutritional needs increases (Wilde, 2002).

Calcium is an essential element required for several life processes. Citrus fruits generally lack in calcium, hence calcium in the form of calcium citrate malate was added to increase the bioavailability and to meet the one third requirements of RDA. Further acid medium enhances the solubility of calcium salts. Food fortification will continue to be an important tool, not only to treat or prevent specific nutritional deficiencies, but also to promote a general state of well being in different populations, and possibly to prevent certain chronic diseases. The identification and development of fortifying agents that will guarantee product quality and high bioavailability are technological and scientific challenges (Karmes *et al* 2006).

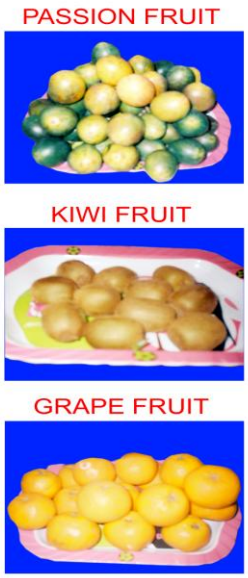
METHODOLOGY

FORMULATION OF STANDARD AND CALCIUM FORTIFIED SQUASHES

SELECTION OF CITRUS FRUITS

The citrus varieties like Grape fruit (Citrus Paradasi), Passion fruit (Passiflora Edulis), Kiwi fruit (Actinidia Deliciosa) are selected for the preparation of standard and fortified squashes. Citrus fruit trees are grown in tropical and subtropical climates. These fruits were procured from the local fruit stall. Maturity is measured depending on different characteristics such as juice content, level of soluble solid (sugar) and solids to acid ratio (Gross, 2002).Food additives such as citric acid, potassium metabisulphite were purchased from the nearby departmental store of reputed brands and checked for its purity. Sugar used for the squashes was also purchased from a retail shop and was checked for its purity. Fruits selected for fortification is given in Plate 1.

PLATE 1
CITRUS FRUITS



SELECTION OF FORTIFICANTS

Calcium fortificants are available in different forms including calcium acetate, calcium carbonate, calcium lactate, calcium citrate, calcium gluconate and calcium citrate malate. Calcium citrate malate is selected due to their superior bioavailability effects. This does not aid stomach acid to be broken down and never leaves to the formation of kidney stones. Another unique advantage comes with taking calcium citrate malate is that unlike other forms of calcium, it never blocks iron absorption. Calcium is critical to the human body's day today function, particularly supporting healthy bones. The fruit juices generally lack minerals especially calcium. So in order to improve the calcium content of the fruit, commercial citrate malate is added to the fruit squash at the ratio of 133 mg per 100 ml to meet the one third requirement of the RDA. Calcium citrate malate was incorporated while preparing sugar syrup in each squash preparation. The flow sheet for the preparation of squashes is given in Figure 1.

Selection of fresh fruits
↓
Washing
↓
Sorting / Grading
↓
Peeling / Coring /Crushing
↓
Extraction of juice
↓
Straining
↓
Measuring the quantity of Extract

↓
Preparation of syrup (sugar + water + acid, heating just to dissolve)
↓
Straining
↓
Calcium fortificant is mixed with the strained syrup
↓
Addition of preservative (0.6 kg KMS / litre squash)
↓
Bottling
↓
Capping
↓
Stored at refrigerated temperature

Figure 1- Preparation of Fruit Squash

FORMULATION AND STANDARDIZATION OF CALCIUM FORTIFIED FRUIT SQUASHES

Ingredients	Quantity
Strained citrus fruit juice (Grape fruit, Passion fruit, Kiwi fruit)	1 liter
Sugar	1.7 g
Water	1.3 liters
Citric acid	20g
Potassium meta bisulphate (KMS)	½ tsp
Calcium fortificant (Calcium citrate malate)	1330 mg

ORGANOLEPTIC EVALUATION & PHYSICOCHEMICAL CHARACTERISTICS OF THE CITRUS FRUIT SQUAHES

Organoleptic evaluation is done to estimate the acceptability of the prepared standard and calcium fortified squashes. The Hedonic scale rating was used to sense the parameters like colour, flavor, texture and taste of the fruit squashes. About ten panel members were selected for the evaluation and the panelists were asked to assess the degree of liking for each sample and the scores obtained were tabulated. The physic chemical parameters such as titrable acidity, total soluble solids were analyzed in the selected standard and calcium fortified citrus fruit squashes. All the parameters were determined on the initial, 15th day and 30th day.

STORAGE STABILITY

During storage the chemical and enzymatic reaction process slowly. Oxygen is the most destructive ingredient in juice causing degradation of Vitamin C. The fruit squashes were stored for a period of one month and the microbial contamination was tested during the initial day, 15th day and 30th day of storage. The contamination of fruit squashes can occur directly or indirectly from manures, water, equipment used. Lactic acid bacteria and yeast are the primary spoilage organisms in fruit beverages (Renee, 2002). The most highly acceptable citrus fruit squash was subjected to refrigerated storage in a glass bottle with crown caps for 30 days. The shelf life of the product was analyzed for bacterial count using standard plate count techniques on the initial, 15th day and 30th day of storage. For bacterial enumeration, nutrient agar was used. Serial dilution is a method which is sequentially diluting a culture through a series of sterile dilutions blank. The need of serial dilution and plating is to determine how many viable cells are rich in each milliliter of the original outhire. The serial dilution of 10^{-5} and 10^{-6} were made for enumerating the bacterial count using spread plate techniques, the samples were periodically analysed for the presence of bacteria. Incubation period for bacterial growth is 48 – 72 hours at 52°C in an incubator.

STATISTICAL ANALYSIS

The overall acceptability scores obtained through sensory evaluation was analyzed statistically using the mean and standard deviation (Gupta, 2003).

RESULTS AND DISCUSISION

NUTRITIVE VALUE OF CALCIUM FORTIFIED CITRUS FRUIT SQUASHES

When the nutritive value of the standard and calcium fortified squashes computed using ICMR table were compared, the vitamin C content for Kiwi fruit squash was the highest (54.38 mg), followed by Grape fruit squash (31 mg). Similarly the energy, calcium and phosphorous levels of kiwi fruit squashes were the highest when compared to other squashes. The beta carotene value of Passion fruit squash was 1968 µg and the protein content for both standard and sample was 1.2g which was found to be higher when compared to other two squashes. Comparison of nutritive value of standard and calcium fortified citrus fruit squashes are given in Table 1.

Table – 1-Comparison of nutritive value of standard and calcium fortified citrus fruit squashes

Nutrients	Grape fruit squash		Passion fruit squash		Kiwi fruit squash	
	Standard	Sample	Standard	Sample	Standard	Sample
Energy (Kcal)	135.4	135.4	231.5	231.5	384.4	384.4
Protein (g)	0.7	0.7	1.2	1.2	1.0	1.0
Fat (g)	0.1	0.1	0.2	0.2	Nil	Nil
Calcium (mg)	13.6	181.18	12	179.58	22.80	190.38
Phosphorous (mg)	13	13	23	23	36	36
Vitamin C (mg)	31	31	15	15	54.38	54.38
Iron (mg)	0.2	0.2	0.2	0.2	Nil	Nil
Beta carotene (µg)	Nil	Nil	1968	1968	Nil	Nil

ORGANOLEPTIC EVALUATION OF CALCIUM FORTIFIED CITRUS FRUIT SQUASHES

The fortification significantly increased the calcium content of all the fruit squashes. The sensory characteristics of calcium fortified citrus fruit squash almost matched with that of all the parameters of standard Grape fruit squash as revealed by the statistical analysis. The overall acceptability scores of standard passion fruit squash was found to be 7.98 and that of calcium fortified passion fruit squash was found to be 7.94. Nearly 60 per cent of the members rated "like moderately" for standard and sample. Statistical analysis of 't' value did not show any significant difference in overall acceptability in standard and sample. About 70 per cent of the panelists rated "like very much" for both standard and sample and there were no responses in the "dislike code". Though the sensory scores of the calcium fortified Kiwi fruit squash was slightly lower than the standard. Statistical analysis did not show any significant difference between them. The mean overall acceptability scores of calcium fortified grape fruit squash was the highest followed by standard Kiwi fruit squash and standard Passion fruit squash. Though statistical analysis did not reveal any significant difference between standard Grape fruit squash and standard Kiwi fruit squash, the mean overall acceptability scores of standard and grape fruit squash was considered as the criteria for selecting the product for further storage study. On comparison of the mean overall acceptability of the different calcium fortified citrus fruit squashes, it was noted that the mean overall acceptability of grape fruit squash was maximum followed by calcium fortified Kiwi fruit squash and calcium fortified Passion fruit squash. Statistical analysis of't' value for overall acceptability revealed significant difference between standard and passion fruit squash. There were no significant difference with regard to overall acceptability between calcium fortified Grape fruit squash and calcium fortified Kiwi fruit squash. However, the mean acceptability score was taken as criteria for subjecting the product to storage.

PHYSICO CHEMICAL PARAMETERS OF THE GRAPE FRUIT SQUASH

The physico chemical parameters such as titrable acidity and Total Soluble Solids (TSS) in Grape fruit squash were determined using standard procedures. The titrable acidity of the standard and calcium fortified Grape fruit squash was found to be 4.0 under refrigerated condition, on the initial as well as on the 30^{th} day of storage. The total soluble solid content of standard Grape fruit squash increased gradually during storage period and the TSS of the sample was greater than that of standard on the initial, 15^{th} day and 30^{th} of storage.

STORAGE STABLITY AND SENSORY ANALYSIS OF THE CALCIUM FORTIFIED GRAPE FRUIT SQUASH

The microbial count of standard Grape fruit squash ranged from 4×10^6 to 5×10^6 cfu /ml during 30 days of storage and that of the sample ranged from 29×10^6 to 43×10^6 cfu /ml. The viable microbial count was identified as Streptococcal species and was found to be in the recommended limits. Microbial count of standard and calcium fortified Grape fruit squash is given in Table 2.

Table – 2- Microbial count of standard and calcium fortifies grape fruit squash

Period of storage	Bacterial Count CFU / ML	
	Standard	Sample
0^{th} day	4×10^6	29×10^6
15^{th} day	5×10^6	34×10^6
30^{th} day	5×10^6	43×10^6

The overall acceptability scores for standard and calcium fortified Grape fruit squash revealed that the product was highly acceptable on the initial and 15^{th} day of storage. The acceptability of both standard and sample gradually decreased on the 30^{th} day of storage. Further the statistical analysis revealed that there was no significant difference between the standard and calcium fortified grape fruit squash on the initial and 15^{th} day. However, there was 5 percent significant difference between both standard and calcium fortified grape fruit squash when compared between 15^{th} and 30^{th} day of storage. The panel members rated "like extremely" for the appearance and colour of the standard and calcium fortified grape fruit squash. About 10, 20, 30 percent scored "like moderately for flavor and texture. About 40 percent rated "like moderately" for the taste of calcium fortified grape fruit squash. Comparison of overall acceptability scores of standard and calcium fortified Grape fruit squash is given in Table 3.

Table – 3- Comparison of overall acceptability of standard and calcium fortified grape fruit squash

Period of storage	Grape fruit squash		Groups compared	't' value	
	Standard	Sample		Standard	Sample
0^{th} day	8.64±0.27	8.58±0.27	0^{th} vs. 15^{th}	1.24^{NS}	1.54^{NS}
15^{th} day	8.56±0.50	8.50±0.52	15^{th} vs. 30^{th}	3.58^{**}	2.79^{**}
30^{th} day	8.52±0.54	8.27±0.91	30^{th} vs. 0^{th}	3.02^{**}	4.42^{**}

NS – Not significant, ** - 5 per cent significant

CONCLUSION

Hence it may be concluded from the above findings that fortification of calcium in citrus fruit squashes increased the calcium content of all the citrus fruit squashes. The standard and calcium fortified Grape fruit squash was found to be highly acceptable through organoleptic evaluation compared to other citrus fruit squashes. It was stable in refrigerated storage in glass bottles up to 30 days of storage.

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