GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(*Published By*: Global Institute for Research & Education)
www.gifre.org

Development of Product Rich in Dietary Fiber and Antioxidant Prepared from Lemon Peel

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ABSTRACT

Lemons contain numerous phytochemicals including polyphenols and terpens[3] As with other citrus fruits, they have significant concentrations of citric acid. Lemon peels were used to obtain high dietary fiber powder. The present study aims to develop a hard candies made from lemon peel and jiggery. The high dietary fiber powder from lemon peel was made by two methods washing and oven drying and evaluation was done for fiber content of the obtained powder. The washed method powder was rich in high dietary fiber (59g) and vitamin C (112.82mg). Hard candies were prepared from this powder. Jaggery was included in the candies to reduce the bitterness of the powder. Candies with different concentrations(5g,7.5g,10g) of this powder were developed. Sensory evaluation was done by Composite score . Results revealed that the crystalline candy prepared with 5g of lemon peel powder were most acceptable. The candy provides (3.2 g) of fibre and Vitamin C (5.2 mg) in 50grams of hard candies.

Keywords: *Lemon peel, Antioxidants, Dietary fiber*

INTRODUCTION

Lemon is an important medicinal plant of the family Rutaceae. It is cultivated mainly for its alkaloids, which are having anticancer activities and the antibacterial potential in crude extracts of different parts (viz., leaves, stem, root and flower) of Lemon against clinically significant bacterial strains has been reported[1] .The origin of the lemon is unknown, though lemons are thought to have first grown in Assam (a region in northeast India), northern Burmaor China.[2] A study of the genetic origin of the lemon reported it to be hybrid between bitter orange (sour orange) and citron.[2]

Lemons contain numerous phytochemicals including polyphenols and terpens[3] As with other citrus fruits, they have significant concentrations of citric acid (about 47 g/l in).[3]

Table 1: Nutritional Composition of lemon with peel and lemon peel[4]

Lemon with Peel(Average size)	
Calories 22	Calories from Fat 3
Total Fat 0.32g	Saturated Fat 0.042g
Polyunsaturated Fat 0.096g	Monounsaturated Fat 0.012g
Sodium Content 3mg	Potassium Content 157mg
Dietary Fiber Content 5.1g	Protein Content 1.3g
Lemon Peel(100 g)	
Calcium 134mg	Potassium 160mg

Lemon and limes are excellent source of vitamin C which is a most important water soluble antioxidant and contains unique flavanoid compounds that have anti-cancer and antioxidant properties. They have been shown to stop cell division in many cancer cells and have other antibiotic properties. Vitamin C acts as a great scavenger and neutralizes any free radical which comes in contact with the aqueous environments in the body. Free radicals can cause lot of harm to the body causing inflammation and painful swellings. Thus vitamins C from limes and lemons have a protective effect against inflammatory conditions like rheumatoid arthritis, osteoarthritis and asthma. A study proved that vitamin C from lemons and limes protection against inflammatory polyarthritis (involving two or more joints), a form of rheumatoid arthritis in subjects who consumed diet rich in vitamin C than those who consumed lowest amounts of vitamin C rich foods. Vitamin C also plays an important role in enhancing the immune system and preventing recurrent infections, colds and flu's. Many researches prove that consuming fruits and vegetable rich in vitamin C helps to reduce the heart diseases, stroke and cancer.

Citrus fruits also contain non-starch polysaccharides (NSP), commonly known as dietary fibre, which is a complex carbohydrate with important health benefits. The predominant type of fibre in citrus is pectin, making up 65 to 70 percent of the total fibre. The remaining fibre is in the form of cellulose, hemicellulose and trace amounts of gums. Citrus also contains lignin, a fibre-like component. In the body, NSP holds water-soluble nutrients in a gel matrix which delays gastric emptying and slows digestion and absorption. This tends to promote satiety, and may reduce the rate of glucose uptake following consumption of glycemic (available) carbohydrate, thus helping to prevent a surge in blood glucose levels. Improper regulation of blood glucose results in either hyperglycemia (high blood glucose) or hypoglycemia (low

blood glucose). NSP can also interfere with the reabsorption of bile acids which may help in lowering plasma cholesterol levels. [5]

ANTIOXIDANT

Lemon and limes are excellent source of vitamin C which is a most important water soluble antioxidant and contains unique flavanoid compounds that have anti-cancer and antioxidant properties. They have been shown to stop cell division in many cancer cells and have other antibiotic properties. Vitamin C acts as a great scavenger and neutralizes any free radical which comes in contact with the aqueous environments in the body. Free radicals can cause lot of harm to the body causing inflammation and painful swellings. Thus vitamins C from limes and lemons have a protective effect against inflammatory conditions like rheumatoid arthritis, osteoarthritis and asthma. A study proved that vitamin C from lemons and limes protection against inflammatory polyarthritis (involving two or more joints), a form of rheumatoid arthritis in subjects who consumed diet rich in vitamin C than those who consumed lowest amounts of vitamin C rich foods. Vitamin C also plays an important role in enhancing the immune system and preventing recurrent infections, colds and flu's. Many researches prove that consuming fruits and vegetable rich in vitamin C helps to reduce the heart diseases, stroke and cancer.

Limonoids are the phytonutrients in limes and lemons have been shown in many animal studies to have a protective effect against mouth, lung, skin, breast, stomach and colon cancer. Body can readily absorb and utilize limonin a type of limonoid which is present extensively in the citrus fruits like limes and lemons.

Peels of lemons and lime are listed among the foods that contain oxalates which can cause health problems. Oxalates when becomes too concentrated can crystallize; they can also combine with calcium to form calcium oxalate stones. Thus it would be wise to avoid the peels of lemons and limes for individuals with already existing or untreated kidney or gallbladder problems. [6]

PHYTOCHEMICALS

These naturally occurring compounds found in plants have a wide range of physiological effects and may help to protect against various chronic diseases, including cancer and heart disease. The wide variety and number of known phytochemicals continue to grow, as does understanding of their role and importance in the diet Several classes of phytochemicals, including monoterpenes, limonoids (triterpenes), flavanoids, carotenoids and hydroxycinnamic acid, have been isolated from citrus. [7]

DIETARY FIBRE

Citrus fruits also contain non-starch polysaccharides (NSP), commonly known as dietary fibre, which is a complex carbohydrate with important health benefits. The predominant type of fibre in citrus is pectin, making up 65 to 70 percent of the total fibre. The remaining fibre is in the form of cellulose, hemicellulose and trace amounts of gums. Citrus also contains lignin, a fibre-like component. In the body, NSP holds water-soluble nutrients in a gel matrix which delays gastric emptying and slows digestion and absorption. This tends to promote satiety, and may reduce the rate of glucose uptake following consumption of glycemic (available) carbohydrate, thus helping to prevent a surge in blood glucose levels. Improper regulation of blood glucose results in either hyperglycemia (high blood glucose) or hypoglycemia (low blood glucose). NSP can also interfere with the reabsorption of bile acids which may help in lowering plasma cholesterol levels. [8]

METHODOLOGY

The study was done under four phases. Phase I was product development. Firstly Lemons were dried and lemon peel was grinded in to a powder the drying was done by two methods (wet oven drying and dry oven drying). In dry oven drying method, the lemon peels(1kg) were cut into pieces and were put into the hot air oven and dried at 70°C.The drying process continued until the mass of sample reached at the equilibrium and seemed to be totally dried. The dried lemon peels were ground using blender and then sieved and packed in the plastic container until analysis. In wet oven drying method the lemon peels (1kg) were washed with water for a min as washing enhances the water holding capacity and then excess water was removed after which the peels were put into the hot air oven and dried at 70°C.The The drying process continued until the mass of sample reached at the equilibrium and seemed to be totally dried. The dried lemon peels were ground using blender and then sieved and packed in the plastic container until analysis. The powder was then analyzed for Fibre content. The result revealed that the fibre content was higher in the wet oven drying powder as compared to dry oven drying powder. The reason can be that the water holding capacity increases when you wet the lemon first and then oven dried the lemons. Therefore, for further analysis wet oven dried lemon peel powder was used. The hard candies were prepared by standardized recipe by without lemon peel powder and taken as control. After the standardization, three variation of hard candies were made, Sample T_1 (Hard candies incorporated with 5g of lemon powder), Sample T_2 (Hard candies incorporated with 7.5g of lemon powder) and Sample 3 (Hard candies incorporated with 10g of lemon powder). Phase II include sensory evaluation of the samples was carried out using 10 panelists from Manav Rachna International University. It was done by composite scoring test. The qualities assessed include appearance, texture, colour, and overall acceptability. Phase III includes Fiber and Vitamin c analysis of the product. The fiber contents were determined by the AOAC.$^{(2000)}$. The last phase was statistically test was done by using SPSS version 20 software. The analysis includes mean, standard deviation, t – test, Anova for comparative results.

RESULTS AND DISCUSSION

The present study was conducted to develop a product from high dietary fiber powder developed from lemon peel i.e. Hard Candies and to evaluate its fiber content, antioxidant properties of the product.

ASSESMENT OF FIBER AND VITAMIN C CONTENT LEVEL BETWEEN WET AND DRY METHOD

Table 1: Nutritional value of lemon peel powder per 100 gms

Nutrients	Methods of Drying		P value
	Dry method	Wet method	
Fiber	48.7 ±0.1	59.9±0.2	0.01
Vitamin C	108.34±0.3	112.82±0.1	0.83

Significant difference at p<0.05

The Table 1 revealed the nutritional value of lemon peel per 100gm.The fiber content and Vitamin C was evaluated .The fiber content by wet method of drying was more (59.90 gm) as compared to dry method (48.7 gm) and the differences were statistically significant (p<0.05) .The Vitamin C content was also more of wet method as compared to dry method but the differences were not statistically significant (p=0.83).So, the above table states that fibre content was more in the lemon peel powder developed from wet method of drying.

Table 2 Mean acceptability score of attributes between the sample T_1, T_2 and T_3 by composite scoring

PARAMETERS	T1	T2	T3	f_{value}	P_{value} (ANOVA)
Appearance*	16.3±1.41	14.5±1.64	12.7±1.94	11.4	0.00
Texture	7.0±1.33	6.1±0.87	6.1±0.87	2.4	0.10
Color	7.50±0.84	6.8±0.78	6.5±1.43	2.3	0.11
Taste*	16.8±1.81	14.7±2.21	14.1±1.59	5.6	0.00
Aroma	7.2±0.78	6.9±0.07	6.0±1.15	4.6	0.11
Mouthfeel*	7.3±1.33	6.1±1.10	5.7±1.49	3.9	0.03
Overall Acceptability	15.6±2.79	14.2±2.18	13.7±1.8	1.8	0.17

*Significance at p <0.05

Sample T_1: Lemon peel candies incorporated with 5gms of peel powder

Sample T_2: Lemon peel candies incorporated with 7.5gms of peel powder

Sample T_3: Lemon peel candies incorporated with 10gms of peel powder

Table 2 depicts the mean acceptability score of attributes between the samples: Hard Candies by composite scoring. In appearance , there was statistically significant difference between the samples (p<0.05) as determined by one-way ANOVA .T_1 has the highest mean value 16.3±1.41 whereas T_3 has lowest mean value 12.7±1.94.So T_1 was more acceptable by the panelists.

For texture T_1 had the highest mean value 7.0±1.33 whereas T_3 has lowest mean value6.1±0.87 and difference was not statistically significant between the samples (p=0.10).

In color T_1 had the highest mean value 7.5±0.84 whereas T_3 has the lowest mean value6.5±1.43 .but there was no statistically significant difference between the samples (p=0.11).

T_1 had the highest mean value regarding taste 16.8±1.81 whereas T_3 has the lowest mean value14.1±1.59 .The results had statistically significant difference between the samples (p<0.05). So T_1 was more acceptable in regards to taste.

In aroma T_1 had the highest mean value 7.2±0.78 and T_3 has the lowest mean value 6.0±1.15 .So there is no statistically significant difference between the samples(p=0.11).

In mouthfeel, there was statistically significant difference(p<0.05) between the samples. T_1 has the highest mean value 7.3±1.33 whereas T_3 has the lowest mean value 5.7±1.49.So T_1 was more acceptable.

The overall acceptability was the highest for T_1 15.6±2.79 and for T_3 was the lowest 13.7±1.8 and the differences were not statistically significant (p=0.17).

Table 3 Mean acceptability score of attributes between the samples: Hard Candies by composite scoring

PARAMETERS	STANDARD	T1	T2	T3	f_{value}	P_{value}
Appearance*	15.3±2.5	16.3±1.41	14.5±1.64	12.7±1.94	6.19	0.02
Texture*	6.6±1.26	7.0±1.33	6.1±0.87	6.1±0.87	1.54	0.21
Color	6.80±1.98	7.50±0.84	6.8±0.78	6.5±1.43	0.97	0.41
Taste*	16.2±2.82	16.8±1.81	14.7±2.21	14.1±1.59	3.4	0.02
Aroma*	6.7±1.25	7.2±0.78	6.9±0.07	6.0±1.15	2.55	0.07
Mouthfeel	6.4±1.71	7.3±1.33	6.1±1.10	5.7±1.49	2.26	0.97
Overall* Acceptability	15.5±2.99	15.6±2.79	14.2±2.18	13.7±1.8	1.50	0.23

*Significance at p<0.05

Standard sample: Normal hard candies

Sample T_1: Lemon peel candies incorporated with 5gms of peel powder

Sample T_2: Lemon peel candies incorporated with 7.5gms of peel powder

Sample T_3: Lemon peel candies incorporated with 10gms of peel powder

Table 3 depicts the mean acceptability score of attributes between the samples: Hard Candies by composite scoring. In appearance , there was statistically significant difference between the samples (p<0.05) as determined by one-way

ANOVA .T_1 has the highest mean value 16.3±1.41 whereas T_3 has lowest mean value 12.7±1.94.So T_1 was more acceptable by the panelists.

For texture T_1 had the highest mean value 7.0±1.33 whereas T_3 has lowest mean value6.1±0.87 and difference was statistically significant between the samples ($p<0.05$). Therefore, T_1 was more acceptable in regards to texture.

In color T_1 had the highest mean value 7.5±0.84 whereas T_3 has the lowest mean value6.5±1.43 .but there was no statistically significant difference between the samples ($p=0.41$).

T_1 had the highest mean value regarding taste 16.8±1.81 whereas T_3 has the lowest mean value14.1±1.59 .The results had statistically significant difference between the samples ($p<0.05$). So T_1 was more acceptable in regards to taste.

In aroma T_1 had the highest mean value 7.2±0.78 and T_3 has the lowest mean value 6.0±1.15 .So there is statistically significant difference between the samples($p<0.05$). So T_1 was more acceptable in regards to aroma.

In mouthfeel, there was no statistically significant difference between the samples. T_1 has the highest mean value 7.3±1.33 whereas T_3 has the lowest mean value 5.7±1.49.

The overall acceptability was the highest for T_1 15.6±2.79 and for T_3 was the lowest 13.7±1.8 and the differences were statistically significant ($p<0.05$). T_1 was most acceptable sample regarding appearance, texture, taste and aroma and overall acceptable regarding all the attributes

Table 4: Proximal Analysis of the product (hard candies, 50g)

Nutrients	STANDARD	T1	T2	T3
F IBER(gm)	-	3.2 ±0.2	4 ±0.3	8.1 ±0.2
VITAMIN C(mg)	-	5.2±0.1	8.6 ±0.1	10.4 ±0.4

Standard sample: Normal hard candies
Sample T_1: Lemon peel candies incorporated with 5gms of peel powder
Sample T_2: Lemon peel candies incorporated with 7.5gms of peel powder
Sample T_3: Lemon peel candies incorporated with 10gms of peel powder

The above table 1.4 shows the proximal analysis of the product in which candies of different variations of lemon peel powder (5gm,7.5gm and 10gm)were there.The fiber content and Vitamin C of T_3 was the highest as it included more of lemon peel powder .On the other side the fiber content and Vitamin C of sample T_1 was the lowest of all as it included 5gms of lemon peel powder. Therefore as the concentration of lemon peel powder was increasing the fiber content and Vitamin C was also increasing in all samples.

CONCLUSION

The present study developed an antioxidant and fibre rich hard crystalline candies which will be beneficial in various medical conditions such as diabetes, obesity, cardiovascular disease, cancers etc. The study concluded that the crystalline candy prepared with 5g of lemon peel powder were most acceptable. The candy provides Fiber (3.2 mg) and Vitamin C (5.2 mg) in 50 grams of hard candies. Also, this study will serve as a base for intervention studies to generate scientific knowledge and evidence which will help to conduct further research.

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