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ORIGINAL ARTICLE

Calorıfıc Values of Different Fruıt Powders

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Abstract

The fruits are having proteins, fats, carbohydrates, vitamins, minerals and sugars as chief content. Protein, fats, carbohydrates contributes the energy content of fruit powder. In the present investigation the calorific value of different fruit powders such as Jackfruit bulb powder, Jamun seed powder, Kokum rind powder, Kokum sarbat powder, Kokum solkadhi powder were analyzed by using digital bomb calorimeter and by chemical composition i.e. by protein, fat and carbohydrate content. It was observed that the calorific value of Jackfruit bulb, Jamun seed, Kokum rind, Kokum Sarabat and Kokum Solkadhi powder was 3.8, 3.6, 3.7, 3.5 and 4.7 kcal/g, respectively. It was observed that the calorific values of different fruit powders increased during storage (0-6 months).

Keywords: Fruit powder, Chemical composition, Calorific value, Digital bomb calorimeter.

1. Introduction

India ranks first in production of fruits and second in vegetables next to China. The annual fruits and vegetables production of India is 32 million tons. Thus, it accounts about 8% of world's fruit production. The fruit production in India has recorded a growth rate of 3-9%. There exist over 4000 fruit processing units in India with an aggregate capacity of more than 12 lakh million tons. India accounts for 15% of the total world's production of fruits and vegetables which is more than 71 million tons. Total area under fruits and vegetable cultivation is around 11.96 million hectares, which is about 5.8% of total area under cultivation in country. Fruits and vegetables are highly perishable commodities. Therefore, the main objective of food processing is to preserve the commodity as long as possible and make the commodity available in off season. The composition of fruit and vegetables is very complex as they are rich source of vitamins and minerals and also contain carbohydrates, sugars, cellulose, pectin, tannin, phenols, acidity, very trace amount of fats and proteins (Karakaya *et al.*, 1994; Shahnawaz *et al.*, 2009; Krishnamurty *et al.*, 1982). To meet the off seasonal requirement of fruits it can be stored in the form of powders, liquids, concentrate, etc. Human being requires certain amount of energy for doing day to day work. Carbohydrates, sugar, fats, water content of fruits provides maximum amount of energy required. This energy can be defined in terms of 'calorie'. Calorie can be defined as amount of heat required to raise the temperature of unit mass of substance through 1°. Calories were first defined by a French chemist, Nicolas Clement, back in 1824. Calories are basically, energy measurement units which are used to gauge the amount of energy stored in foods. "Kilocalories" are also attributed as calorie.

It is recommended that, daily requirement of calories for girls aged 9-13 year is 1600 cal, boys aged 9-13 year is 1800 cal and for children it is 400 cal. Also, the calorie required for adult men is 1800-2000 cal, for adult women is 2200-2400 cal. A common practice is not to allow more than 30% of daily calories to come from fats. One gram of fat gives 9 calories, 1 gram of protein gives 4 calories and 1 gram of carbohydrate gives 4 calories (Potter and Hotchkiss, 1997). Government also has taken interest in nutritional content of foods. Various laws are also established such as Nutritional Labelling and Education Act (NLEA). "Nutrition facts" labelling required on nearly all foods. All nutrients amounts in the "Nutritional Facts" section are based on standard serving size which has been determined by the FDA. Most of the nutrients are labelled based on "percent (%) of daily value" (Potter and Hotchkiss, 1997). Section 16 of the Food Safety and Standard Act, 2006 of Govt. of India has given the emphasis for food labelling. Food labelling standards including claims on health, nutrition, special dietary uses and food category systems for foods (FSSA, 2006).

Various methods have been used for determination of calorific value of different products

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using bomb calorimeters such as digital bomb calorimeter, oxy-bomb calorimeters (Benedis and Fox, 1925), redwood bomb calorimeter, etc. Determination of calorific value by nutritional analysis involves determination of fats, proteins and carbohydrates, by summing all we get calorific value of that particular product (Merrill and Watt, 1982).

Kokum fruits contain rich amounts of anti-oxidants that combine with free radicals and avoid oxidative damage to body cells. They also support cell regeneration and repair, Kokum juice is especially popular during scorching summer months as the cooling properties of kokum, oil of the fruit is used as emollient and antiseptic. It also helps in bringing down fever and allergic reactions (Swami *et al.*, 2014; 2015). Amrut kokum is a drink made of sugar syrup and kokum fruit to treat sun-stroke (Krishnamurty *et al.*, 1998). Jackfruit (*Artocarpus heterophyllus L.*) is an exotic fruit grown in tropical climates. The yellowish bulbs constituting the perianth portion of the fruit are fleshy, fibrous, and rich in sugars as well as carotenoids. Each bulb has a single seed, which is edible after roasting. Rahman *et al.* (1999) described the fruit as a rich source of carbohydrates, minerals, carboxylic acids, dietary fibre, vitamins such as ascorbic acid (AA) and thiamine. The jackfruit bulbs may be used as raw or cooked (with coconut milk or otherwise); or made into ice cream, chutney, jam, jelly, paste, "leather" or *papad*, or canned in syrup with sugar or honey along with addition of citric acid. Jamun can be used for making jelly, jam, preserve, squash and wine-making. It contains essential oil which possesses antimicrobial properties and the extracts reduce blood sugar and glycosuria. Extracts of bark, stem, leaf, buds and flowers possess moderate antibiotic activity (Shahnawaz *et al.*, 2009).

Considering the need of determination of calorific value of Jackfruit bulb powder, Kokum powder, Jamun powder, Kokum Sarbat powder and kokum Solkadhi powder shown in Fig 1, which are developed in NAIP on A value chain for Kokum, Karonda, Jamun and Jackfruit has taken as raw material in the present study. The study was undertaken to determine chemical composition of selected fruit powders and to determine the calorific values of these powders by different methods.

2. Materials and Methods

2.1 Determination of Chemical Composition of Sample Fruit Powders

Various samples of fruit powders were taken for determination of chemical composition namely Jackfruit bulb powder, Jamun seed powder, Kokum rind powder, Kokum sarbat powder, Kokum solkadhi powder. The powders were taken for storage study after 1, 3 and 6 months.

2.1.1 Moisture Content

Moisture content was determined by hot air oven as outlined in AOAC Method 934.01 (AOAC, 1990). 10 g sample was taken in moisture box. Weight of moisture box and sample was recorded. Moisture box without lid was placed in hot air oven at 105 ± 20ºC for 24 h. Moisture content on dry basis was calculated by using Eq. (1).

$$\text{Moisture } (\%) = \frac{(W1-W2)}{W1-W} \times 100 \quad ...(1)$$

Where;

w_1 = weight of sample + moisture box;
w_2 = weight of box + sample after drying;
w =weight of box.

2.1.2 Fat Content

The total crude fat was measured using the ether extraction method 920.39C (AOAC, 1990) and fat contents were calculated as percentages of the dry weight of samples. Fat content was determined using Soxhlet apparatus (Elico, Hyderabad, India). Empty round bottom flask was weighed. Five gram sample of powder was taken for analysis. Sample was wrapped in filter paper and was put in thumbnail. About 150 mL of petroleum ether was taken in round bottom flask. Some of it was poured in the thumbnail, so that the sample was merged in petroleum ether up to its half. Assembling of all this with soxhlet tube was done. Heating was started 9-12 siphon for better results. Flask was removed from assembly. Flask containing petroleum ether was heated openly till it evaporates. Residues remained at bottom and were re-weighed. Fat content was calculated by using Eq. (2)

$$\% \text{ fat content } = \frac{\text{final wt.} - \text{inial wt}}{\text{wt.of sample}} \times 100 ...(2)$$

2.1.3 Protein Content

Protein content of different fruit powders was analysed by using spectrophotometer (Make: Systronics- Double beam UV-VIS spectrophotometer; Model No: 2201). Firstly, alkaline sodium carbonate was prepared by mixing 20 g Na_2CO_3 and 0.1 N NaOH. Copper sulphate - sodium potassium tartarate is then prepared by mixing 7 g of sodium potassium tartarate in 700 mL of distilled water and then 3.5 g of copper sulphate pentahydrate was added. 1 g of sample was dissolved in 50 mL of distilled water to form a test solution. Alkaline solution was freshly prepared by mixing alkaline sodium carbonate and Copper sulphate

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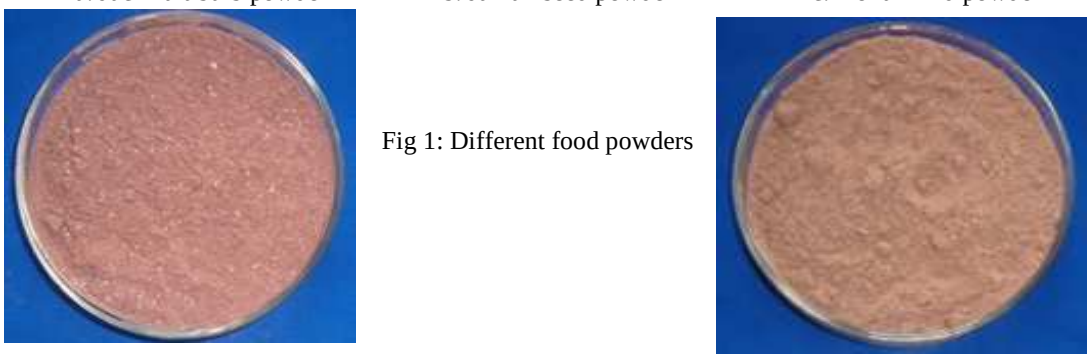
a. Jackfruit bulb powder b. Jamun seed powder c. Kokumrind powder



d. Kokum Sarbat Powder e. Kokum solkadhi powder

Fig 1: Different food powders

– sodium potassium tartarate. 1 mL of test solution was taken out and 5 mL of alkaline solution was added and mixed it thoroughly and kept it at room temperature for 5 min. Then 0.5 mL folin-ciocalteu reagent was added immediate after mixing and kept it as it is for 30 min. Extinction against 750 nm and standard curve was prepared absorbance against concentration to read the unknown sample. For this, 10 g of albumin was dissolved in 50 mL of distilled water from this 25 mL was dissolved in 50 mL of distilled water, 12.5 mL from first solution was then dissolved in 50 mL of distilled water. 6.25 mL of first solution was added in 50 mL of distilled water. Readings of unknown sample were taken according to standard curve.

2.1.4 Carbohydrate Content

Carbohydrates content of different fruit powders was calculated by using spectrophotometer (make: Elico-double beam UV spectrophotometer, Hyderabad; Model SL-164). Firstly, series was prepared. For preparation of series 1 g of glucose powder was dissolved in approximately 50 mL of water. Then volume is made upto100 ml in a volumetric flask. After this 10 mL of it pipette out and again volume was made upto 100 mL in volumetric flask and 5-6 drops of toluene were added. Then series was made by mixing glucose stock and distilled water. Always make volume of 1 mL of both. Read the extinction at 630 nm and form standard curve by concentration vs absorbance.

After preparation of series, samples were prepared. For the preparation of test solution, 1 g of sample was weighed and taken it in to test tube 5 mL of 2.5 N of HCl. Then it was heated in water bath for 3 h. Solid sodium carbonate was then added till the effervescence stopped. Volume was made up to 100 mL and kept it for filtration. 0.6 mL of filtered powder solution was taken and 0.4 mL distilled water was added. Anthrone reagent was formed by mixing 2 mg of anthrone powder to 100 mL of H_2SO_4. 4 mL of prepared anthrone reagent was added in each sample. The mixture was heated for 8 min. Spectrophotometer was started and kept it for preliminary heating and set it for 630 nm. Sample was poured in cuvette. Extinction was read against concentration vs. absorbance.

2.1.5 Determination of Ash Content

Ash content of all sample powders was estimated using muffle furnace. 5 g material of each sample powder was taken in crucible. Weight of crucible and sample was recorded. Then it was heated on gentle heat for 10 min. and kept in muffle furnace at 550°C for 4-5 h followed by cooling in desiccators. Ash content was calculated by using formula (Eq 3);

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Ash content, %= $\frac{(W2-W)100}{W1-W}$...(3)

Where;

W_2- weight of crucible with ash.

W_1- weight of crucible and sample powder.

W- weight of crucible.

2.2 Estimation of Calorific Value by Chemical Composition

Chemical compositions such as fat content, protein content and carbohydrate content calculated were used for determination of calorific value. Energy obtained from proteins, carbohydrates and fats were calculated by general rule of 4-4-9 (Potter and Hotchkiss, 1997).

Energy from proteins (kcal) = amount of proteins present × 4 ...(4)

Energy from carbohydrates (kcal) = amount of carbohydrates present × 4 ...(5)

Energy from fats (kcal) = amount of fats present × 9 ...(6)

2.3 Calorific Value Determination Using Digital Bomb Calorimeter

The Digital bomb calorimeter (Make: Parr Instrument Company, USA; Model: 6110) which was used for determination of calorific value. Firstly the stirrer assembly was opened and switched on the equipment. Pre-weighed sample pallet of nearly 1 g was taken and put in metallic crucible. The crucible was placed in vertical stand provided in the instrument. One end of thread was tied to the wire and other end surrounded the sample pallet. After this the crucible with sample was loaded in a bomb. The disc was rotated and fitted properly inside the bomb. The oxygen cylinder to the bomb was connected and pressed calorimeter operation button on and joined O_2 fill button and filled it at 450 psi till it sounds beef voice. The O_2 outlet is removed, 2 litre distilled water was filled in SS bucket. The bomb was hold in the clamp and placed it in the bomb calorimeter in such a way that the electrode should be in outer side of the fan to prevent contact between two. The bomb should exactly beat the centre of bucket. The stirrer shaft assembly was closed after that Pressed the START button. Pressed NO button for removal of earlier ID from the memory and gave the new sample ID. Bomb ID-1 was entered and pushed ENTER. Also entered pallet sample weight and pressed ENTER. Wait for 7-10 min. Idle condition (time required for combustion i.e. firing) was achieved. Wait till red strip converted in to green. The ENTER was then pushed and the file was selected from file list. Pushed DISPLAY and noted down energy reading, (cal/g) directly.

2.4 Determination of Calorific Value by Jain's Bomb Calorimeter

Various samples of fruit powders were taken for determination of calorific value namely Jackfruit bulb powder, Jamun seed powder, Kokum rind powder, Kokum sarbat powder, Kokum solkadhi powder. The powders were taken for 3 months interval 1, 3 and 6 month for storage study.

The Jain's Bomb Calorimeter, 1 g of sample was taken for determination of calorific value. Weighed sample was taken in a crucible. Water was filled in outer jacket of bomb calorimeter. Magnesium wire and thread together were tied to rods at lid. The crucible was kept in such a way that Magnesium wire and thread should be come in contact with sample. Oxygen is filled at 25 atm. Bomb was checked thoroughly to check the oxygen leakage if any in the bomb. Bomb was placed in calorimeter. The initial temperature of outer and inner jacket was recorded. Blasting was done for burning of sample. Readings were recorded and calorific value was calculated by using Eq. (7)

Calorific value = $\frac{(W+w)(T_2-T_1)}{x}$ ... (7)

Where,

W - Weight of water taken.

W - Water equivalent.

x - Weight of sample used.

T_2 - final temperature.

T_1 - initial temperature.

3. Results and Discussion

Table 1 gives the chemical constituents of Jackfruit bulb powder, Jamun seed powder, Kokum rind powder, Kokum Sarabat powder, Kokum Solkadhi powder etc. Table 2 gives the ANOVA for the chemical composition at different storage durations.

3.1 Calorific Value Using Digital Bomb Calorimeter

Table 3gives the calorific value of Jackfruit bulb powder for storage period 1st month to 6th month. Table 4 shows the ANOVA for the calorific values of different fruit powders stored from period 1 month to 6 months. It is clear from the graph, the calorific value of jackfruit powder increases from 3669.86 cal/g to 3859.92 cal/g. As the storage life increases from first month to sixth month, the calorific value also increases. These increases of the calorific values are not significantly different at $p \leq 0.5$.

Table 2 shows the calorific value of Jamun seed

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Table 1: Chemical composition of fruit powders

Powders	Chemical constituents	Month 1	Month 3	Month 6
Jackfruit bulb powder	Moisture content	17.64%	18.62%	18.83%
	Fat	7.20%	7.89%	6.89%
	Protein	4.8%	5.2%	5.1%
	Carbohydrate	9.5%	10.43%	9.83%
	Ash	7.16%	7.76%	8.1%
Jamun seed powder	Moisture content	15.78%	15.60%	15.28%
	Fat	4.44%	5.56%	5.21%
	Protein	4.8%	5.2%	5.1%
	Carbohydrate	11.35%	12.03%	13.15%
	Ash	3.9%	3.7%	3.9%
Kokum rind powder	Moisture content	16.27%	16.89%	16.28%
	Fat	9.30%	9.41%	9.11%
	Protein	4.5%	4.6%	5.3%
	Carbohydrate	29%	31.8%	32%
	Ash	5.03%	4.93%	5.10%
Kokum sarbat powder	Moisture content	19.04%	19.76%	19.04%
	Fat	9.14%	9.73%	9.66%
	Protein	5.98%	6.63%	6.06%
	Carbohydrate	32.4%	31.83%	32.16%
	Ash	7.53%	7.43%	7.70%
Solkadhi powder	Moisture content	20.48%	20.07%	20.91%
	Fat	7.10%	7.33%	7.25%
	Protein	6.23%	5.73%	6.63%
	Carbohydrate	32.92%	32.13%	30.41%
	Ash	9.23%	9.43%	9.7%

(Significant at p≤0.05)

powder for storage period 1st month to 6th month. It is clear from the graph, the calorific value of Jamun seed powder increases from 3697.72 cal/g to 3710.25 cal/g. As storage life increases from first month to sixth month, the calorific value also increases. These increases of the calorific values are not significantly different at p≤0.5.

Table 2 shows the calorific value of Kokum rind powder for storage period 1st month to 6th month. It is clear from the graph, the calorific value of Kokum rind powder increases from 3695.22 cal/g to 3799.44 cal/g from first month to sixth month, this increase of the calorific values are not significantly different at p≤0.5.

Table 2 shows the calorific value of Kokum sarbat powder for storage period 1st month to 6th month. It is clear from the graph, the calorific value of Kokum sarabat powder increases from 3479.83 cal/g to 3589.69 cal/g. As storage life increases from first month to sixth month, the calorific value also increases. These increases of the calorific values are not significantly different at p≤0.5.

Table 2 shows the calorific value of kokum solkadhi powder for storage period 1st month to 6th month. It is clear from the graph, the calorific value of kokum solkadhi powder increases from 4689.24 cal/g to 4723.10 cal/g from first month to sixth month, this increase of the calorific values are not significantly different at p≤0.5.

3.2 Comparison of Calorific Values of Fruit Powders for Digital Bomb Calorimeter, Jains Bomb Calorimeter and by Chemical Method

Table 2 shows the comparison of calorific values of Jackfruit bulb powder, Jamun seed powder, Kokum rind powder, Kokum Sarabat powder and Kokum Solkadhi powder determined by Digital Bomb Calorimeter, Jains bomb calorimeter and by chemical method. It was observed that as the period of storage increases from 1st month to 6th month, the calorific values are increases for all the food powders for both the three methods. The calorific value of Jackfruit bulb

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Table 2: ANOVA for change of chemical compositions of fruit powders

Source of Variation	SS	df	MS	F	P-value	F crit
Jackfruit bulb powder						
Between Groups	0.031984	4	0.00799	345.3583	1.14348×10^{-10}	3.478
Within Groups	0.000232	10	2.32×10^{-05}	-	-	-
Total	0.032215	14	-	-	-	-
Jamun Seed Powder						
Between Groups	0.032607	4	0.008152	319.6149	1.68×10^{-10}	3.478
Within Groups	0.000255	10	2.55×10^{-05}	-	-	-
Total	0.032862	14	-	-	-	-
Kokum rind powder						
Between Groups	0.143421	4	0.035855	567.3709	9.71×10^{-12}	3.478
Within Groups	0.000632	10	6.32×10^{-05}	-	-	-
Total	0.144053	14	-	-	-	-
Kokum Sarbat powder						
Between Groups	0.142308	4	0.035577	3537.417	1.05×10^{-15}	3.478
Within Groups	0.000101	10	1.01×10^{-05}	-	-	-
Total	0.142408	14	-	-	-	-
Kokum Solkadhi powder						
Between Groups	0.144509	4	0.036127	861.7619	1.21×10^{-12}	3.478
Within Groups	0.000419	10	4.19×10^{-05}	-	-	-
Total	0.144929	14	-	-	-	-

Table 3: Comparison of calorific values by Digital bomb calorimeter, Jain's bomb calorimeter and using chemical analysis for I month, III Month and VI month of storage.

Month	Powder name	Calorific values (cal/g)		
		Digital bomb calorimeter	Jain's bomb calorimeter	Chemical composition
I	Jackfruit bulb powder	3699.867	3669.670	3679.372
	Jamun Seed Powder	3697.729	3620.439	3659.430
	Kokum Rind Powder	3695.226	3647.148	3648.620
	Kokum Sarabat Powder	3479.830	3511.004	3524.640
	Kokum Solkadhi Powder	4723.102	4758.241	4724.520
III	Jackfruit bulb powder	3775.451	3861.003	3893.720
	Jamun Seed Powder	3387.331	3482.089	3468.430
	Kokum Rind Powder	3715.221	3680.190	3783.080
	Kokum Sarabat Powder	3591.106	3586.181	3580.720
	Kokum Solkadhi Powder	4723.102	4788.903	4877.464
VI	Jackfruit bulbs powder	3859.921	3889.855	3875.640
	Jamun Seed Powder	3680.200	3686.140	3692.929
	Kokum Rind Powder	3729.012	3702.237	3799.440
	Kokum Sarabat Powder	3682.242	3598.528	3589.692
	Kokum Solkadhi Powder	4689.231	4699.809	4604.944

(Significant at $p \leq 0.05$)

powder varies from 3669.675 cal/g to 3699.867 cal/g for 1st month, 3775.451 cal/g to 3893.720 cal/g for 3rd month, 3859.921cal/g to 3889.855 cal/g for 6th month. The calorific value of Jamun seed powder varies from 3620.439 cal/g to 3697.729 cal/g for 1st month, 3387.331 cal/g to 3482.089 cal/g for 3rd month and 3680.200cal/g to 3692.929cal/g for 6th month. The calorific value of Kokum rind powder varies from 3647.148 cal/g to 3695.226 cal/g for 1st month, 3680.190 cal/g to 3783.080 cal/g for 3rd month,

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Table 4: ANOVA for calorific value of fruit powders

Source of Variation	SS	df	MS	F	P-value	F crit
Jackfruit bulb powder						
Between Groups	63671.93	2	31835.96	22.78669	0.001575	5.143253
Within Groups	8382.778	6	1397.13	-	-	-
Total	72054.71	8	-	-	-	-
Jamun Seed Powder						
Between Groups	104043.7	2	52021.83	37.53537	0.000405	5.143253
Within Groups	8315.651	6	1385.942	-	-	-
Total	112359.3	8	-	-	-	-
Kokum rind powder						
Between Groups	10592.61	2	5296.303	2.645978	0.150019	5.143253
Within Groups	12009.86	6	2001.643	-	-	-
Total	22602.46	8	-	-	-	-
Kokum Sarbat powder						
Between Groups	21942.76	2	10971.38	10.4053	0.011208	5.143253
Within Groups	6326.418	6	1054.403	-	-	-
Total	28269.18	8	-	-	-	-
Kokum Solkadhi powder						
Between Groups	26112.47	2	13056.24	4.305052	0.069262	5.143253
Within Groups	18196.63	6	3032.771	-	-	-
Total	44309.1	8	-	-	-	-

3702.237 cal/g to 3799.44 cal/g for 6th month. The calorific value of Kokum sarabat powder varied from 3479.831 cal/g to 3524.640 cal/g for 1st month, 3580.720 cal/g to 3591.106 cal/g for 3rd month, 3589.692 cal/g to 3682.242 cal/g for 6th month. The calorific value of Kokum solkadhi powder varies from 4723.102 cal/g to 4758.241 cal/g for 1st month, 4723.102 cal/g to 4877.464 cal/g for 3rd month, 4604.944 cal/g to 4699.809 cal/g for 6th month. The calorific value obtained by different methods such as Digital bomb calorimeter, Jain's bomb calorimeter and using nutritional analysis are not much varying either with respect to month of storage or with respect to method of estimation.

4. Conclusions

The calorific value of above studied fruit powders varied from 3.5 to 4.7 kcal/g with KokamSolkadhi powder showed highest value. Determination of calorific value by Digital bomb calorimeter is the faster and more accurate method than other two methods.As the storage period increases the calorific value increases for different fruit powders.

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