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RESEARCH ARTICLE

PREPARATION OF CALCIUM-DENSE CAULIFLOWER LEAF POWDER BY DIFFERENT METHODS & SELECTION OF THE MOST SUITABLE METHOD

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ABSTRACT

Calcium is an integral component of bones and teeth. Being present in minute amounts, calcium is essential for maintaining several physiological functions. However, most Indians usually consume low-calcium diet. There is evidence of widespread osteoporosis, bone fractures, osteopenia, bone pain and reduced bone mass, particularly in post-menopausal women. Cauliflower green is a low-cost, calcium-rich (626mg/100g) leafy vegetable which can be dried by various methods but the calcium content varies as the processing method varies. In the present study, fresh cauliflower leaves were collected, washed, weighed and dried in five different ways namely sun-drying, shade-drying, microwave-drying, oven-drying and roasting methods and then grinded into powder and weighed again. All the drying methods produced good quality CLP but the total yields (15.12-20.76%) and calcium contents (578-762mg/100g of fresh leaves) of CLP samples varied as the processing method varies.Roasting is the best method for the preparation of CLP, considering all the advantages and disadvantages of five processing methods used. It is suggested that roasted CLP can be used as vegetable calcium supplement which can easily be incorporated into the many recipes commonly used in the day-to-day menu of the people. Regular consumption of CLP may be helpful for preventing and reducing the prevalence of calcium deficiency disorder.

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INTRODUCTION

Daily intake of adequate calcium is essential for human beings. Calcium makes up between 1.5-2% of the body weight, of which almost 99% calcium is found in the bones and teeth and rest is distributed in the blood, muscles, liver and heart (Srilakshmi, 2006). The skeletal and non-skeletal calcium (Ca^{2+}) are in equilibrium. The calcium can be drawn upon from bones to make up the deficiency of blood calcium and when the deficit is made up calcium is again re-deposited in bones (Pravina *et al*., 2013). Blood calcium level is maintained within narrow range with the interplay of vitamin D and several hormones by controlling absorption, excretion and bone turnover (ICMR, 2009). Formation and maturity of the bones and teeth is the primary function of the calcium whereas non-skeletal calcium plays an essential role in the maintenance of neuromuscular excitement, blood coagulation, membrane permeability etc. Adults require calcium to replace the calcium drainage from the body through urine, stools, bile and sweat. The daily calcium loss is around 700mg in an adult.

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Additional calcium is required during growth periods (for skeletal development and maturation), lactation (for supplying calcium in milk secreted) and old age (for preventing excessive bone resorption). Total calcium intake includes the consumption of both dietary calcium as well as calcium supplements. Milk and other dairy products are rich in calcium whereas cereals provide only moderate amount of it. Ragi and green leafy vegetables are also good sources of calcium. Grains, legumes, fruits, meat, poultry, fish and eggs also supply certain amounts of calcium. In developing countries, like India, intake of dairy products is substantially low and most dietary calcium comes from cereals which is responsible for regular dietary inadequacy of calcium in most Indians, particularly those from lower and middle socio-economic classes. There is evidence of widespread calcium depletion, as indicated by bone density measurements, particularly in women after repeated pregnancy and lactation. Attaining peak bone densities is essential to prevent osteoporotic fractures later in life. Women from low income group are exposed to a greater risk of developing bone abnormalities due to long-term poor nutrition, particularly dietary calcium deficiency.

According to the Indian Council of Medical Research the recommended dietary allowances (RDA) for calcium is as follows

Table 1. RDA for calcium

Group	Recommended intakes of calcium
Adult men and women	600 mg/day
Pregnant and lactating women	1200 mg/day
Post-menopausal women	800 mg/day
Infants	500 mg/day
1 to 9 years boys and girls	600 mg/day
10 to 18 years boys and girls	800 mg/day

Deficiency of calcium is responsible for developing many symptoms like

1. Muscle cramping in legs, particularly at night, is one of the first signs of calcium deficiency.
2. Joint pains, cardiac palpitations, increased cholesterol levels, slow pulse rates, insomnia, impaired growth, excessive irritability, dry skin, brittle nails, yellowish teeth etc. are the symptoms of moderate calcium deficiency.
3. Osteoporosis and frequent bone fractures results from chronic calcium deficiency (Pravina *et al*., 2013).

Osteoporosis is the most common type of bone disorder in adults, primarily affecting middle-aged and elderly people, 80% of them women, mostly post-menopausal women(Guyton, 2006). It affects the entire skeletal system, causing shrinkage of vertebrae, height loss, hunched backs, bone pain and frequent fractures (Tortora, 2009). Osteoporosis affects around 40% women and 14% men over 50 years of age (Eastell, 2002). Repeated bone fractures as well as poor and slow recovery from it, causes pain and invites movement disability which is a major problem of old age. Osteoporosis-related morbidity and mortality, as well as health care costs, have significant public health concern (Institute of Medicine, 2011). Regular intake of a balanced diet, containing adequate amount of calcium, magnesium, potassium and vitamin D throughout the life is essential for maintaining good skeletal health (Tucker, 2009; Miggiano *et al*., 2005). In our country, a large section of the population remains below the poverty line. They mainly subsist on inadequate intake of poor quality cereal based vegetable diet, devoid of milk. It is usually not possible for them to incorporate substantial amount of milk in their daily diet. As a result of dietary calcium inadequacy, skeletal problems are frequently observed among them.

In this scenario, if it is possible to develop a low-cost, calcium-rich vegetable supplementary powder and distribute it among the poverty-stricken people, it may be helpful to ensure adequate calcium intake according to the prescribed guidelines. In general, green leafy vegetables (GLVs) are good source of calcium. Hence, nutritious underutilized seasonally available GLV can be explored to prepare calcium-rich supplementary leaf powder.

Cauliflower (*Brassica oleraceae* var. Botrytis) is one of the most frequently consumed vegetable in India but their leaves are rarely consumed by the common people. Fresh cauliflower leaf is a seasonal, nutritious, calcium rich (626mg/100g), tasteful green leafy vegetable but it contain around 80% moisture which makes it highly perishable (Gopalan *et al*., 2004) As the fresh cauliflower leaves are usually considered as a waste in the vegetable market, it can easily be collected at zero cost. If it is possible to dry the fresh leaves into cauliflower leaf powder (CLP), it may be used as a calcium rich, low cost supplement that can be incorporated into many recipes of our daily menu. So, to utilize the high calcium potential of the cauliflower greens, it is needed to be dried and processed.

Cauliflower leaves were dried by various methods by many scientists but the calcium content of CLP samples varies depending on the drying method used. Wani *et al*. (2011) prepared CLP by collecting cauliflower leaves from the local market of Jammu city, India. These leaves were then washed with water, blanched for10-15 seconds, and were dried at room temperature for 1-2 hours, followed by drying in hot air oven at 40^0C for 4-6 hours and then ground to fine powder. The dried CLP contained only 2.41% moisture. According to Mogra *et al*. (2012), CLP was developed by drying leaves at 40°C temperature for 22 hours using mechanical drier. 100g of this CLP contains 3600mg calcium. Singh, *et al*. (2005) evaluated the nutritive value of products prepared from dried powder of cauliflower leaves. The leaves of cauliflower (*Brassica oleracea*) were dried, powdered and used for preparing namakpara, kurmura, biscuit and cake. These studies showed that cauliflower leaves can be dried using various processing methods.

A research work was conducted by Wani and Sood (2014) to observe the effect of incorporation of cauliflower leaf powder on sensory and nutritional composition of malted wheat biscuits. The malted wheat flour was blended with CLP in the ratios of 10, 20 and 30% for the development of biscuits. The developed products were stored for 90 days to ascertain the changes in proximate composition and sensory characteristics. On the basis of sensory evaluation, biscuits prepared from 90:10 malted wheat flour: cauliflower leaf powder, was considered the best regarding their acceptability and storability. Joshi *et al*. (2010) analysed the nutritional potential and acceptability of leaf mixtures (LM), prepared from the less utilized leaves of beet root (*Beta vulgaris*), carrot (*Daucuscarota*), cauliflower (*Brassica oleracea*) and turnip (*Brassica rapa*), in a definite ratio of 1:2:1:1. Twenty different recipes with different levels (0, 5, 10, 15 and 20%) of LM incorporation were prepared and were assessed for quality on the basis of sensory attributes. The products were well accepted up-to the level of 10%. Protein, iron and calcium content were significantly higher in the LM incorporated recipes and the increase was directly proportional to the level of leaf mixture incorporated. Wani *et al*. (2011) conducted a study on the nutritional and sensory properties of roasted wheat noodles supplemented with CLP. The results of this study indicated that samples of CLP enriched noodles, for all addition levels, contained more protein, fibre and ash as compared to control sample. The above studies indicated that cauliflower leaf powder could be successfully incorporated into many recipes to improve their nutrient contents.

Various researchers dried and cooked many underutilized green leafy vegetables using various methods and estimated their calcium contents which showed that processing methods largely determined the yield and calcium level in the processed leaves. Lyimo *et al*. (2010) suggested that there is a need to choose the appropriate processing methods having minimum nutrient losses. Sakhale, *et al*. (2007), dried the curry leaves by sun drying, shade drying and tray drying methods. The yield of shade dried curry leaves was highest compared to other methods.

Oladele and Aborisade (2009) studied the influence of sun-drying, shade drying and oven drying methods on the mineral contents of Indian spinach which showed that calcium was well retained in the dried leaves but calcium contents were varied from sample to sample. The study of Umoh and Iwe (2014) on the effects of processing on the nutrient composition of false yam (*Icacinatrichantha*) flour indicated that there was significant differences in calcium content of steeped sun-dried and oven-dried as well as blanched sun-dried and oven-dried flour samples. Kiremire *et al*. (2010) estimated the calcium retention of traditionally sun dried, solar dried and oven dried *Amaranthushybridus, Amaranthusblitum and Amaranthuscruentus* samples which indicated that calcium was well retained in the dried leaves but the percentage of retention varied depending on the drying methods. According to the study of Lyimo, *et al*. (2010) in Tanzania, processing of sweet potato varieties by boiling, roasting and sun drying caused no significant ($p>0.05$) effect on calcium content. In another study Mepba *et al*. (2007) studied the effects of processing treatments on the nutritive composition of eight leafy vegetables. In this study the calcium contents of raw, sundried, blanched and cooked vegetable samples were estimated which showed that the calcium level remain almost same in both raw and sundried leafy vegetable sample but it varies slightly depending on the sample and the processing methods used.

Abioye, *et al*. (2014) studied the effects of different drying methods on the nutritional attributes of baobab leaves (Adansoniadigitata) in Nigeria. They dried the baobab leaves by sun drying, shade drying, cabinet drying and solar drying methods and analyzed the nutrient contents in both the fresh and processed leaves. This study showed that fresh baobab leaves are good sources of calcium (90mg/100g) and the calcium level increased during all types of processing of leaves. This study also showed that there is significant difference in proximate components, ascorbic acid and mineral contents between the leaves undergoes through different drying methods.

Previous studies indicated that the cauliflower leaf is a neglected calcium-rich green leafy vegetable, which can be dried by several methods and converted into powdered form. Cauliflower Leaf Powder (CLP) can be incorporated into different recipes to improve their calcium content. Calcium is usually well retained in the dried green leafy vegetables but the extent of calcium retention largely depends on the drying method used.

Aims and Objectives

The aims and objectives of the present study include

1. To prepare cauliflower leaf powder (CLP) from freshly collected cauliflower leaves by using different home-based processing methods namely sun-drying, shade drying, microwave-drying, oven-drying and roasting methods.
2. To assess the total yields of the cauliflower leaf powder from 100g of fresh leaves.
3. To estimate and compare the calcium content of the fresh cauliflower leaves as well as five types of dry CLP samples.
4. To select the most suitable processing method for drying the fresh cauliflower leaves.

MATERIALS AND METHODS

Preparation of dry cauliflower leaf powder (CLP) in five different methods

1. Collection of raw material: Fresh cauliflower leaves were collected from the local market of the south Kolkata, West Bengal at zero cost.
2. Sorting, washing and weighing of fresh leaves: Only the good quality leaves were considered as a raw material and they were washed thoroughly with clean, running tap water to remove all the dirt, and other non-edible matters. Then the excess water was removed from clean leaves by spreading them on a dry, clean cloth.
3. Drying of fresh leaves in 5 different ways to prepare five types of CLPs: Five sets of weighed fresh leaves were taken for further processing in following methods

a) *Preparation of sun dried CLP:* Weighed amount of raw materials were kept in single layer in a tray under the sun for 3 days and dried until the crisp, brittle dry leaves were obtained. The dry leaves were then grinded into a fine powder using a grinder, minutely collected, accurately weighed and subsequently stored in air tight plastic container in a cool and dry place.

b) *Preparation of shade dried CLP:* The fresh cauliflower leaves were weighed and spread over a dry, clean cloth and kept in a well-ventilated, clean room for about 4 days at room temperature and dried adequately. Then the dry leaves were powdered by using a grinder, weighed and kept in air tight container.

c) *Preparation of microwave dried CLP:* The fresh cauliflower leaves were weighed and dried in the microwave oven at 140^0C for 18 minutes, powdered, weighed again and stored.

d) *Preparation of oven dried CLP:* The weighed, fresh leaves were dried in the oven dryer at 100^0C for 4 hours, grinded into powder, weighed, kept in air tight container and stored.

e) *Preparation of roasted CLP:* Weighed amount of fresh leaves were roasted on tawa, initially for 5 minutes, at moderate flame, followed by another 5 minutes at low flame, so that the leaves become crisp and brittle to touch. Then the roasted leaves were finely grinded into fine powder to make cauliflower leaf powder (CLP). As a source of heat mud oven, kerosene stove burner or gas oven, whatever available in the home can be used. The freshly prepared CLP was now weighed and stored at room temperature.

All the five sets of fresh leaves were optimally dried to obtain a crispy textured dried leaves which can easily be converted into uniform fine powder.

Estimation of total yield of dry CLP from 100g of fresh leaves

Five sets of 100g fresh cauliflower leaves were separately and accurately weighed, processed in five different ways and converted into cauliflower leaf powder (CLP), and weighed again (Raghuramulu, 2003).

Preparation of ash extract for Calcium estimation

5g of the sample was weighed accurately into a porcelain crucible, completely charred over flame, heated at 600°C for 4 hours in muffle furnace, cooled in a desiccator & weighed again. To ensure completion of ash preparation, the crucible was again heated in the muffle furnace for 4 hours. This was repeated till two consecutive weights were the same.

Ash content (g/100g sample) = (Wt. of the ash/Wt. of the sample taken) x 100

5ml of $^{N}/_{2}$ HCL was poured into the ash and was heated on flame. Then it was again washed with 5ml $^{N}/_{2}$ HCL & the process was repeated for 3-4 times. Now the solution was filtered with filter paper in a 100ml volumetric flask and the volume was make up with distilled water.

The above method was applied for the all samples (Raghuramulu, 2003).

Estimation of calcium content of five 5 differently processed CLP samples by EDTA titrimetric method (Das, 2006 and Nielsen, 2010).

Principles

Determination of a metal ion by titration with strongly chelating ligands using metal ion indicator is called complexometric titration. Usually sodium salt of EDTA is used as chelating ligands due to its commercial availability, satisfaction of coordination number in a single step formation of a soluble complex without any precipitate, fast reaction rate and formation of highly stable complex than the usual metal ion indicator which helps the reaction to be quantitative. EDTA is the disodium salt of ethylene diamine tetra acetic acid denoted as Na_2H_2EDTA.The solubility of EDTA complex depends on the pH of the solution & the presence of the other chelating ligands. Depending on the pH, metal ion indicator is chosen. The metal ion indicators are chelating agent, which form colour complex with specific metals. The sharpness of the end point increases with increasing pH but magnesium and calcium precipitate as their hydroxides at pH 12. Hence, titration pH should not be more than 11 to ensure their solubility. Considering all factors, EDTA complex metric titration of calcium and magnesium is specified at pH 10 ± 0.1 using an ammonia buffer.

In the estimation of metal ion with EDTA in presence of EBT indicator colour change occur from wine red to blue at the equivalent point. As ca++ ions form a relatively, stable complex with EDTA, but much less stable complex with EBT indicator, on sharp end point is observed in Ca++ ion only. For this reason, to get sharp end point, a little of 0.1(m) Na_2Mg EDTA is to be added to Ca++ solution, before titration. As a result more stable $Na_2CaEDTA$ will be obtained in the solution releasing equivalent amount of Mg++. The released Mg++ then reacts with EBT indicator to form wine red Mg- In- & the colour change at the equivalent point will be from wine red to blue in presence of NH_4CL/NH_4OH buffer of pH 10.0.

Procedure

a) Standardisation of EDTA solution:

10 ml of standard zinc acetate solution was taken in a 250ml conical flask and was diluted with 20ml of distilled water.1ml of NH_4CL/NH_4OH buffer solution and 4-5 drops of EBT indicator was added to the solution. The colour of the solution turned wine red. The solution was titrated with Na_2H_2EDTA solution, until wine red colour turned pure blue.

b) Estimation of Ca2+ ion in unknown solution:

10ml of the unknown Ca2+ solution was pipette out in a 250ml conical flask and diluted with 20ml distilled water. Then 1ml of NH_4CL/NH_4OH buffer solution and 4-5 drops of EBT indicator was added. The colour of the solution turned wine red. Now the solution was titrated with Na_2H_2EDTA solution, until wine red colour turned pure blue.

Calculation

Step1: Standardisation of EDTA solution:

V_1=Volume of zinc acetate solution, S_1= Strength of zinc acetate solution
V_2=Volume of Na_2H_2EDTAsolution consumed and S_2= Strength of Na_2H_2EDTA solution
$V_1S_1=V_2S_2$, or $S_2=V_1S_1/V_2$
Step2: Estimation of Ca2+ ion in unknown solution:
V_1=Volume of unknown calcium solution, S_1= Strength of unknown calcium solution
V_2=Volume of Na_2H_2EDTA solution consumed and S_2 = Strength of Na_2H_2EDTA solution
$V_1 S_1= V_2 S_2$, or $S_1= V_2 S_2/ V_1$

By using above formula, the strength of unknown calcium solution (mg/100ml) is calculated. Since, 100ml of unknown calcium solution is equivalent to 5g of food sample; the amount calcium present in 100g of food was then calculated.

RESULTS

Fresh cauliflower leaves were collected, washed thoroughly with water, dried in five different methods and then grinded to make fine powders. Though all the 5 drying methods are able to produce good quality leaf powder, the total yields of CLP obtained from fresh leaves varied, ranging from 15.12-20.76%, as the processing methods varied.

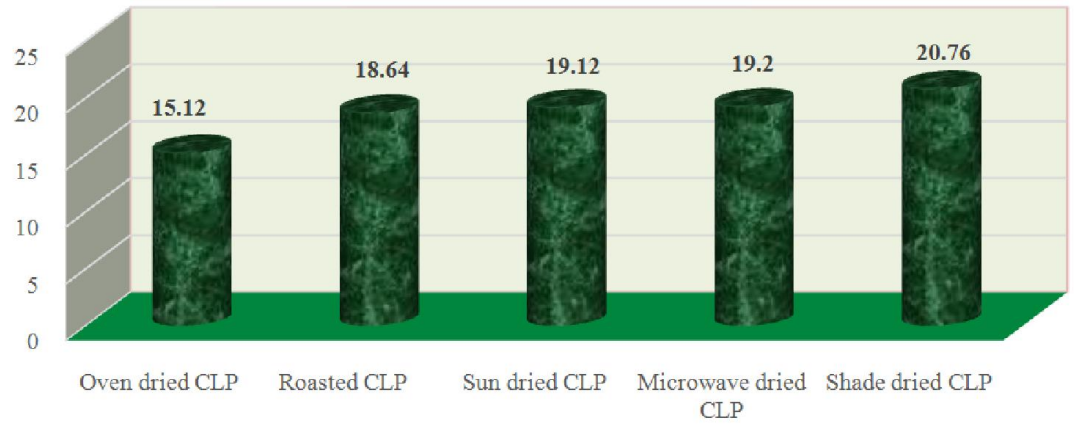

Fig. 1. Total yield of CLP from fresh leaves (g/100g of fresh leaves)

Table 2. Calcium content of the leaf samples (mg/100g of fresh leaves)

Name of the sample	No of observation	Mean Calcium content ± S.E (mg)	T-VALUE	P-VALUE
Fresh leaves	2	666.24 ± 16.24		
Sun dried CLP	2	761.7 ± 3.03	5.7784 (Fresh vs. sun dried CLP)	Highly Significant (P < 0.02)
Shade dried CLP	2	734.78 ± 3.295	4.1359 (Fresh vs. shade dried CLP)	Significant (P < 0.05)
Microwave dried CLP	2	697.22 ± 3.67	6.5156 (Fresh vs. microwave dried CLP)	Highly Significant (P < 0.01)
Oven dried CLP	2	578.35 ± 2.4	5.3538 (Fresh vs. oven dried CLP)	Highly Significant (P < 0.02)
Roasted CLP	2	711.51 ± 1.48	2.7761 (Fresh vs. roasted CLP)	Highly Significant (P < 0.01)

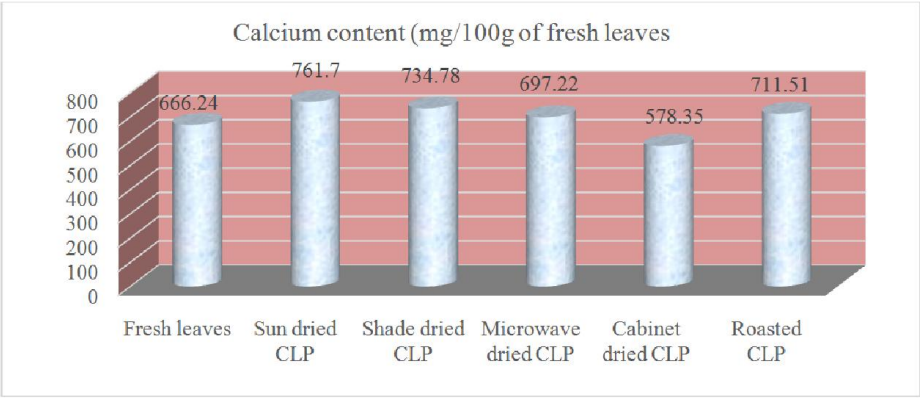

Fig. 2.Calcium content (g/100g) of fresh and processed leaves

Calcium assessment of fresh leaves and differently processed cauliflower leaf powder samples showed that 100g fresh leaves contain 666mg calcium whereas that of processed samples varied from 578-762mg/100g of fresh leaves. Among the samples, oven dried CLP contain lowest amount of calcium whereas sun dried CLP contain highest amount of calcium. All the processed leaves have significantly higher calcium content.

DISCUSSION

In our country, dietary calcium inadequacy is frequently observed, particularly those from lower and middle socio-economic classes. Cauliflower leaf is a seasonal, rarely used, calcium-rich, highly perishable green leafy vegetable. In the present study, fresh cauliflower leaves were collected from the local market, washed thoroughly with clean water, weighed, and dried by five different processes namely sun-drying, shade-drying, microwave drying, oven-drying and roasting methods.

Finally the differently processed leaves were grinded into powder, collected accurately, weighed again and kept separately in air-tight containers. Now the total yield of CLP and calcium content of 5 differently processed CLP samples were estimated by suitable methods.

The similarities, dissimilarities, advantages and disadvantages of 5 processing methods are summarised in the following table (Table 3).

Estimation of total yields of CLP from fresh leaves varied from 15.12-20.76% depending on the drying method used. Variation in yields were basically due to variation in moisture contents and variation in the loss of volatile compounds of the respective samples.

This may indicate that efficiency of removal of moisture is inversely related with the total yield of CLP.

Table 3. Comparison of 5 methods of CLP preparation

Characteristics	Sun dried CLP	Shade dried CLP	Microwave dried CLP	Oven dried CLP	Roasted CLP
Time of exposure to heat and air	Around 20 hours depending on the extent of sunlight	Around 30 hours depending on the temperature and humidity of the room	18 minutes	4 hours	10 minutes
Temperature of processing	Varies	Varies	140^0C	100^0C	Using gas oven at moderate and low flame.
Exposure to U.V. rays	20 hours exposed to the U.V. rays of sunlight	Not exposed.	Not exposed.	Not exposed.	Not exposed.
Apparatus used	No apparatus	No apparatus	Microwave oven	Electric Oven	Gas oven.
Electricity	Not required	Not required	Electricity is required for operating the microwave oven.	Electricity is required for operating the oven dryer.	Not required
Operating cost	Zero cost.	Zero cost.	Cost of the method include initial cost of purchasing the microwave oven as well as cost of electricity to run the machine	Cost of the method include initial cost of purchasing the oven dryer as well as cost of electricity to run the machine.	Cost of fuel is only required. As a source of heat mud oven, kerosene stove burner or gas oven, whatever available in the home can be used.
Risk of contamination	Chances of contamination with dust, dirt and impurities etc. are high but risk of microbial contamination is low because of the exposure of sunlight, heat and U.V. rays.	Both the chances of contamination with dust, dirt and impurities etc. and risk of microbial contamination are high because the product is only exposed to humid air.	No risk of contamination as the leaves are not exposed to any physical or microbial contaminants.	No risk of contamination because the leaves are not exposed to any contaminants.	Since the leaves are not kept in open area, the risk of contamination is minimum.
Implications	This method is implicated in rural and tribal areas.	This method is implicated in rural and tribal areas where availability of sunlight is limited.	This method is implicated for the middle and upper class families.	This method is implicated for the large-scale production of dry cauliflower leaf powder.	This method is implicated anyone from all socio-economic classes.
Overall advantages	1. It is a zero cost, traditional convenient method.	1. It is a zero cost, convenient method.	1. It is a quick and convenient method.	1. It is a quick and convenient method.	1. It is a low cost, quick, convenient method with, requiring no special apparatus or electricity or sunlight.
	2. It does not require any special apparatus or availability of electricity.	2. No special apparatus or availability of electricity is required.	2. There is no risk of contamination.	2. There is no risk of contamination.	2. There is no risk of contamination.
Overall disadvantages	1. It depends on the availability of sunlight.	1. Risk of spoilage of leaves and chance of contamination are high.	1. This is comparatively costly method.	1. This is comparatively costly method.	1. A source of heat is required for roasting.
	2. It requires long time and sun lighten space.	2. It requires long time and adequate space.	2. Requires microwave oven and electricity supply.	2. Requires oven dryer and electricity supply.	

Calcium assessment of fresh leaves and cauliflower leaf powders showed that 100g fresh leaves contain 666mg calcium whereas that of processed cauliflower leaf powder samples varied from 578-762mg/100g of fresh leaves. Similar trends were observed in the findings of a recent study conducted by Abioye *et al*. (2014) on the effects of different drying methods on the nutritional attributes of baobab leaves (*Adansonia digitata*), which showed that fresh baobab leaves are good sources of calcium (90mg/100g) and the calcium level increased during all types of processing of leaves. The present study suggested that both fresh cauliflower leaves as well as processed cauliflower leaf powder (CLP) can be utilized as a calcium-dense vegetable supplements which can effectively be used to enrich the daily diet of the common people.

The present study indicated that among the five different processing methods applied, sun drying is the most traditional cheap and convenient method which is able to efficiently convert the fresh leaves into the dried CLP. But sun-drying process requires adequate sunlight, space and prolong period of time and there is increased risk of physical and biological contamination in this method. Shade-drying process also able to effectively retain the calcium contents but the risk of spoilage and contamination is highest in this method. Comparing all the advantages and disadvantages of the 5 processing techniques, roasting is considered as the most suitable and flexible method which may be adapted by the people from all socio-economic classes. It requires minimum time and exposure to heat and air. This process does not require

any special equipment or electricity or availability of sunlight. As the leaves are not kept in an open place for long time, the risk of physical and microbial contamination as well as chance of spoilage is minimum. This is a very low cost method as the cost only includes the cost of fuel required for the roasting process. The total yield and calcium retention is satisfactory for this method.

Conclusion

It may be concluded that both fresh cauliflower leaves as well as CLP are rich sources of calcium. Fresh leaves can be dried by many methods and all the methods well retained the calcium content of leaves. But the calcium content varies as the method of processing varies. Roasting is the best method for the preparation of CLP, considering all the advantages and disadvantages of five processing methods used. It is suggested that roasted dry CLP can be used as vegetable calcium supplement which can easily be incorporated into the many recipes commonly used in the day-to-day menu of the people. Regular consumption of CLP may be helpful for preventing and reducing the prevalence of calcium deficiency disorders.

REFERENCES

A Report of the Expert Group of the Indian Council of Medical Research, 2009. Nutrient Requirements and Recommended Dietary Allowances for Indians. Hyderabad, India: National Institute of Nutrition.

Abioye, V.F., Adejuyitan, J.A. and Idowu, C.F. 2014. Effects of different drying methods on the nutritional and quality attributes of baobab leaves (Adansonia digitata). *Agriculture and Biology Journal of North America*, 5 (3), 104-108.

Das, S.C. 2006. Advance Practical Chemistry. Kolkata.

Eastell, R. and Lambert, H. 2002. Strategies for skeletal health in the elderly. The Proceedings of the Nutrition Society. 61 (2), pp.173-80.

Gopalon, C., Ramasastri, B.V., Balasubramanian, S.C. 2004. *Nutritive Value of Indian Foods*, Hyderabad, National Institute of Nutrition, Indian Council of Medical Research.

Guyton, A.C and Hall, J.E. 2006. Textbook in Medical Physiology. 11th ed. Philadelphia: Elsevier Saunders.

Institute of Medicine (U.S.) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium. 2011. Overview of Calcium'. In: Ross, A.C., Taylor, C.L., Yaktine, A.L., *et al*. (ed), Dietary Reference Intakes for Vitamin D and Calcium. Washington (DC): National Academies Press (US). pp.35-74.

Joshi, P. and Mathu B. 2010. Preparation of value added products from the leaf powders of dehydrated less utilized green leafy vegetables. *Journal of Horticulture and Forestry*, 2 (9), pp. 223–228.

Kiremire *et al*. 2010. Effects of vegetable drying techniques on nutrient content: a case study of South-Western Uganda. *African Journal of Food Agriculture Nutrition and Development*, 10 (5), 2587-2600.

Lyimo, M.E., gimbi, D. M. and Kihinga, T. 2010. Effect of processing methods on nutrient contents of six sweet potato varieties grown in Lake Zone of Tanzania. *Tanzania Journal of Agricultural Sciences*, 10 (1), 55-61.

Mepba, H.D., Eboh, L. and banigo, D.E.B. 2007. Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. *African Journal of Food Agriculture Nutrition and Development*, 7 (1), 1-18.

Miggiano, G.A. and Gagliardi, L. 2005. Diet, nutrition and bone health. Clin Ter. 156 (1-2), pp.47-56

Mogra, R., Banga, J. and Rathi, P. 2012. Nutrient composition of cauliflower (*Brassica oleracea* var. Botrytis) leaf powder and its acceptability in fast food snacks. *Food Science Research Journal*,3 (2):167-171.

Nielsen, S.S. 2010. *FoodAnalysis*, 4th ed. New York, USA: Springer.

Oladele, O.O and Aborisade, A.T. 2009. Influence of different drying methods and storage on the quality of Indian spinach (*Basellarubra L*). *American Journal of Food Technology*, 4 (2), 66-70.

Pravina, P., Sayaji, D. and Avinash, M. 2013. Calcium and its Role in Human Body. *International Journal of Research in Pharmaceutical and Biomedical Sciences*, 4 (2), pp.659-668.

Raghuramulu, N., Nair, K. and Kalyanasundarum, S. 2003. A Manual of Laboratory Techniques. 2nd ed. National Institute of Nutrition, Hyderabad, India.

Sakhale *et al*. 2007. Studies on dehydration of curry leaves. *ADIT J of Engg*., 4 (1), 62-64.

Singh, G., Kawatra, A., Sehgal, S. 2005. Development and nutritional evaluation of products prepared from dried powder of cauliflower leaves. *Journal of Food Science and Technology*, 42 (2):137–139

Srilakshmi, B. 2006. Nutrition Science. 2nd ed. New Delhi, India: New Age International Publishers.

Tortora, G.J. and Derrickson, B. 2009. Principles of Anatomy and Physiology. 12th ed. United States of America: John Wiley & Sons, Inc.

Tucker, K.L. 2009. Osteoporosis prevention and nutrition. Current osteoporosis reports. 7 (4), pp.111-7.

Umoh, E.O &Iwe, M.O. 2014. Effects of processing on the nutrient composition of false yam (*Icacina trichantha*) flour. *Nigerian Food Journal*, 32 (2), 1-7.

Wani, T.A. and Sood, M. 2014. Effect of incorporation of cauliflower leaf powder on sensory and nutritional composition of malted wheat biscuits. *African Journal of Biotechnology*, 13 (9), pp. 1019-1026.

Wani, T.A., Sood, M. and Kaul, R.K. 2011. Nutritional and sensory properties of roasted wheat noodles supplemented with cauliflower leaf powder. *Annals Food Science and Technology*, 12 (2):102-107.

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