DEVELOPMENT OF VALUE ADDED PRODUCTS WITH INCORPORATION OF COLOCASIA LEAVES

(Colocasia esculenta)

By

MS. Pratibha Basvanta Thombare

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VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH

PARBHANI- 431 402 (M.S.) INDIA

2018
CERTIFICATE-I

This is to certify that Miss. Pratibha Basavanta Thombare has satisfactorily prosecuted her course of research for a period of not less than two semesters and that her dissertation entitled, “Development of value added products with incorporation of colocasia leaves” submitted by her is the result of original research work and is of sufficiently high standard to warrant it’s presentation to the examination.

I also certify that, the dissertation or part of there has not been previously submitted by her for the award of degree of any University.

Place: Parbhani
Date : 31.05.2018

Dr. Farooqui Hafeez Farzana
Assistant Professor
Department of Foods and Nutrition
College of Home Science
VNMKV, Parbhani
CERTIFICATE-II

This is to certify that the dissertation entitled “Development of value added products with incorporation of colocasia leaves” submitted by Miss. Pratibha Basavanta Thombare to the Vasantrso Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of Master of Science (Home Science) in the subject of ‘Foods and Nutrition’ has been approved by the Student’s Advisory Committee after oral examination in collaboration with the External Member.

(External Member) Dr. Farooqui Hafeez Farzana
Research guide
Assistant Professor
Department of Food Science and Nutrition
College of Community Science

Members of Advisory Committee

Professor and Head
Dr. Nalwade V. M.
Department of Food Science and Nutrition
Professor & Head
College of Community Science

Dr. Asha Arya
Professor (CAS)
Dept. of Food Science and Nutrition
College of Community Science

Dr. T. N. Khan
Professor (CAS)
Dept. of Food Science and Nutrition
College of Community Science

Associate Dean and Principal
College of Community Science
VNMKV, Parbhani.
CANDIDATE’S DECLARATION

I, hereby declare that this dissertation or part there of

has not been submitted by me to

any other University or institute for a

degree or diploma

Place : Parbhani

Date : 31.05.2018

(Pratibha Basvanta Thombre)
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(P.B. Thombare)
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CHAPTER 1

INTRODUCTION

Colocasia is an important food crop of West Africa and Oceania. Origin of colocasia is South or South–East Asia. It is an herbaceous plant that grows to the height 1-2m. Colocasia leaves are also called as taro. The leaves and the corn are the edible part that are easily digestible. It is a warm season crop and flourishes in areas receiving plenty of rainfall. The leaf stem may be green, purple or mottled. The leaf may be green, reddish, black or variegated.

Colocasia is a member of the Araceae family is an ancient crop grown throughout the humid tropics for its edible corns, cormels and leaves, as well as for other traditional uses. Cocoyam is a well known food plant which has a long history of cultivation. Its corns are important source of starch. The corns can be cut up and boiled in curries or fried to make crispy chips. The leaf stalk and matured leaves are also eaten as vegetables (Odedeji et al, 2014).

Vegetables serve as an indispensable constituent of the diet supplying the body with minerals, vitamins and hormone precursors in addition to protein and energy. Colocasia leaves have been reported to be rich in nutrients, including minerals such as calcium, phosphorus, iron, and vitamins like vitamin C, thiamine, riboflavin and niacin. High level of dietary fibres in colocasia are also advantageous for their active role in the regulation of intestinal transit, increasing dietary bulk, faeces consistency due to their ability to absorb water (Melese and Negussie, 2015).

Colocasia leaves are of great medicinal value and is included in many ayurvedic preparations. Plants are rich source of bioactive phytochemicals, which can occur in different forms, such as proteins or peptides, carotenoids, polyphenols, isoflavones and sterols. (Abuajah et al, 2015). Such bioactive compounds are used for defense, exerting pharmacological or toxicological effects in animals and humans (Patricia et al, 2015).
The fresh leaves of colocasia had moisture content of 83.4 to 87.0 per cent with a total soluble solid (TSS) varying from 1.8-2°B. Drying of fresh leaves without any pre-treatment and in the absence of blanching resulted in undesirable colour changes from green which is a typical of fresh vegetable to olive brown or brown discoloration. Blanching of colocasia leaves in water for 10 seconds or in alkali like sodium bicarbonate (0.1%) resulted in superior product with unlike the steam blanched or unblanched leaves by showing minimal loss of green colour as reflected in chlorophyll content and nutritional characteristics.

Fresh colocasia leaves (green variety) contain moisture 82.7g, protein 3.9g, fat 1.5g, minerals 2.5g, crude fiber 2.9g, carbohydrate 6.8g, energy 56 Kcal, calcium 227mg, phosphorus 82mg, iron 10mg, copper 0.18mg (Gopalan et al., 1989).

The ash content of ranges from 3.54 to 7.78 per cent (Nijoku and Ohia, 2007; Mbofung et al., 2006). Colocasia is a good source of minerals including iron (8.66-10.8mg/100gm), calcium (31-132mg/100g), sodium (82-1521.34mg/100g), magnesium (118-415.07mg/100g), phosphorus (72.21-340mg/100g), zinc (2.63mg/100g), copper (1.04mg/100g) and an excellent source of potassium (2271-4276.06mg/100g). High potassium to sodium ratio of food recommended for patient with high blood pressure (Melese and Negussie, 2015)

Fresh leaves of colocasia had a phenol content (28.33-30.53µg/100g) and ascorbic acid (19.5-22.7mg) thus highlighting its antioxidant activity. The fibre and ash content of colocasia leaves ranged between 0.87-1.47 and 10.6-12.2% respectively. The pH of the fresh colocasia leaves was recorded as 7.70-7.76, thus slight change in its pH may result in colour change or chlorophyll degradation (Kaushal et al, 2013). Leaves of colocasia are cooked and eaten as vegetable and are said to contain B-carotene, iron and folic acid which protects against anaemia and are important source of proteins and vitamins just like the
corns of cocoyam. The main nutrient supplied by cocoyam, is as with other roots and tubers is dietary energy provided by carbohydrates.

The leaves of colocasia are very easily digestible, since they are rich in dietary fiber, they do a great help to the digestive system. The fibre in them increases the stools, bulkiness and normalizes the bowel movements. It prevents some digestive problem like IBS (Irritable Bowel Syndrome) and constipation. It reduces the risk of colon cancer. The leaves of colocasia have enormous amounts of vitamin A, which is required to support different body functions even including eyes. It prevents different eye disorders like myopia, blindness and cataract.

Regularly consuming freshly cooked colocasia, one is sure to keep off dangerous disease like cancer. This is due to the presence of vitamin C in them. Vitamin C is a protective and powerful antioxidant that can prevent common ailments like cold, cough certain cancers. This vitamin is also required for the growth of strong connective tissues like tendons, cartilage and ligaments. It improves the overall immunity level of the body, speeds the healing process of injuries, and assists in the synthesis of neurotransmitters and hormones. The leaves of colocasia contain enormous amounts of phenolic and carotenoid compounds, which tend to exhibit potent antioxidant properties. Both these chemical compounds help the body to fight free radicals and takes care of the cells from further damage and oxidative stress.

Colocasia leaves are usually consumed by humans after heat treatments, such as boiling, steaming, stewing, frying and pressure cooking. These methods are found to be affective in improving digestibility, increasing bioavailability and also minimizing food-borne diseases. Through boiling also reduce the nutritional value of food crops arising from significant losses and changes in major nutrients during cooking.

Soluble oxalates may be lost by leaching during boiling but they will be retained in the leaves during baking. It is also possible that during baking
soluble oxalates may leach from the wrapping leaves into the food being cooked. Boiling the colocasia leaves resulted in a 36% loss of soluble oxalates, while the insoluble oxalate content of baked tissue was very similar to the raw tissue. Soaking the raw leaves in water for 30 min marginally reduces the soluble oxalate content by leaching into the tap water, while soaking for 18 hrs is much more effective as 26% of soluble oxalate is leached into the tap water. The mean insoluble oxalate content of the soaked leaves (168.35 mg/100 g) was very similar to the insoluble oxalate content of the raw tissue.

The leaves of colocasia have 0% cholesterol and total fat contributes by only 1%. The compound methionine and dietary fiber present in colocasia leaves lower the cholesterol efficiently by breaking the triglyceride down. Colocasia is rich in an amino acid named threonine. This compound helps in the formation of collagen and elastin, both of which are vital for healthy skin. Hence, eating the vegetable on a regular basis prevents wrinkles and rejuvenates the skin at the same time. Colocasia has low levels of saturated fat, and that is the major reason why it is claimed to be a healthy food for the heart. The fiber content present in them stops the accretion of cholesterol and fat in the blood streams whereas the potassium assists in maintaining a normal blood pressure. It lowers the homocysteine levels in the blood and saves from heart problems and strokes. It breaks down and absorbs carbohydrates, builds muscles, controls the overall electrolyte balance.

Colocasia leaves are a good source of vitamin folate. Iron is one of the indispensable minerals because it plays a very important role in the development of RBCs and in the transportation of oxygen to various body parts. People, who are anemic, need to consume colocasia on a daily basis, as it not only fulfills the iron deficiency but also avoids fatigue, weakness, and tiredness.

The main problem in the consumption of the leaves of colocasia is the presence of anti-nutritional factors. These factors may have adverse effects on
health through inhibition of protein digestion, growth, iron and zinc absorption. However, all parts of the raw colocasia plant are known to contain oxalate, which must be destroyed by thorough cooking before eating. The presence of oxalate causes sharp irritation and burning sensation in the mouth and throat when tubers or leaves are eaten. In order to reduce the effect of antinutrients, proper processing before consumption is necessary.

. Colocasia leaves are consumed by after cooking, either by boiling, blanching, steaming, stewing, frying or pressure cooking. These methods are found to be effective in improving digestibility, increasing nutrient availability and also minimizing food-borne diseases. Though, boiling can help to reduce the oxalate content in the leaves of this species, it may also reduce the nutritional value of food crops arising from significant losses and changes in major nutrients during cooking (Lewu et al., 2009).

In Maharastra and Gujrat states the leaves are used to make a fried snacks which is prepared by applying besan (gram flour) on the leaves and frying them. The various products made out of colocasia green leaves are colocasia sour curry, colocasia spicy cutlets, boiled colocasia curry, arvi moti (kanapakana.com), patra (Gujarati recipe), samosa, lavingya paatra, turiya paatra, aluvadi paatra (https://m.tarladalal.com). In Maharastra state, the leaves are used to make a sweet sour curry with peanuts and cashewnuts (common dish made during marriages) and the leaf bases made into a side dish ‘Dethi’ with curd.

The present study is planned to study the development of value added products with incorporation of colocasia leaves will be undertaken with following objectives.
1. To develop food products by incorporating fresh and dry colocasia leaves
2. To evaluate the organoleptic qualities of developed food products
3. To analyze nutrient content of highly accepted developed food products
4. To study the shelf life of developed food products.
CHAPTER 2

REVIEW OF LITERATURE

Colocasia leaves are rich in minerals such as calcium, phosphorus, iron, and vitamins like vitamin C, thiamine, riboflavin and niacin. High level of dietary fibres in colocasia is also advantageous for their active role in the regulation of intestinal transit, increasing dietary bulk, faeces consistency due to their ability to absorb water (Melese and Negussie, 2015).

Colocasia leaves are easily digestible, since they are rich in dietary fiber, they do a great help to the digestive system. The fibre in the leaves increases the stools bulkiness and normalizes the bowel movements. It prevents digestive problem like irritable bowel syndrome and constipation. It reduces the risk of colon cancer. High levels of dietary fiber in colocasia are also advantageous for their active role in the regulation of intestinal transit, increasing dietary bulk and faeces consistency due to their ability to absorb water. Most rural peoples suffer from malnutrition not because of economic status but because of inability to utilize the available nutritious raw materials to meet their daily requirements.

Zinc deficiency is widespread and affects the health and wellbeing of populations worldwide and since colocasia is one of the few non-animal sources of zinc, its utilization should therefore be pursued to help in the alleviation of zinc deficiency which is associated to stunting.

The leaves of colocasia have enormous amounts of vitamin A, which is required to support different body functions. It prevents different eye disorders like myopia, blindness and cataract.

The studies which have been documented in the literature on incorporation of fresh and dried colocasia leaves are reviewed in this chapter under various heads.
2.1. Studies on different methods of cooking of colocasia leaves.

2.2. Studies on nutritional content of colocasia leaves.

2.3. Studies on antinutritional content of colocasia leaves.

2.4. Studies on development of food products with incorporation of colocasia leaves fresh and dry.

2.1. Studies on different methods of cooking of colocasia leaves

Savage and Dubois (2006) studied the effect of soaking and cooking on the oxalate content of colocasia leaves. Boiling the colocasia leaves resulted in a 36% loss of soluble oxalates. The soluble oxalate content of the raw leaves was 236.10 mg oxalate/100 g. Soaking the raw leaves in water for 30 min marginally reduces the soluble oxalate content. Soaking for 18 hrs results in a 26% reduction in the soluble oxalate content of the raw leaves. Boiling the taro leaves resulted in a 36% loss of soluble oxalates.

Mepba et al., (2007) assessed that leafy vegetables are highly perishable food items and require special processing treatments to prevent post harvest losses. Leafy vegetables to be preserved by canning, freezing or dehydration are normally blanched in order to obtain good quality products. Blanching and cooking caused significant (P≤ 0.05) reductions in the K, Na, Ca, Zn, Fe and P contents of amaranths, tomatoes, fluted pumpkin nectum vegetable, spinach, slippery vine and colocasia leaves. The Vitamin C contents of raw vegetables ranged from 37.5 – 205.4mg/100g. The various treatments likesun-drying, blanching and cooking caused significant (P≤0.05) losses of Vitamin C.

Agoreyo et al., (2011) studied the effect of various drying methods on the nutritional composition of musaparadisiaca, diacorearotundata and colocasia esculanta. These food crops were dried using various drying methods and their nutritional composition determined. Analysis of their nutritional composition showed that these drying methods significantly lowered the moisture content of these food samples (p<0.001), with solar dried samples having the lowest moisture content compared to the
fresh samples. The carbohydrate content of all the dried samples were significantly lowered (p<0.01) compared to the fresh samples, however, the solar dried samples had the highest values except for the cocoyam sample. Protein and lipid contents of all the dried samples also decreased significantly (p<0.001). On the other hand, ash and fibre contents of all the dried samples increased significantly (p<0.001) compared to the fresh samples. Calcium content of the dried samples of yam and colocasia decreased but that of the plantain samples increased, however, this increase was not significant except for the sun dried sample. The three drying methods used in this study resulted in an increase in the magnesium content of both plantain and yam samples, however, that of colocasia decreased compared to the fresh samples. These results indicate that the effects of the various drying methods on the food samples were almost similar, with each drying method retaining the nutrients, without total loss of any nutrient; although, with some degree of loss to some nutrients.

Kausal et al., (2013) investigated that fresh leaves of colocasia had a moisture content of 83.4 to 47.0 % with a total soluble solid varying from 1.8-3.2°B. Drying of fresh leaves without any pre-treatment and in the absence of blanching resulted in undesirable colour changes green which is a typical of fresh vegetables to olive brown or brown discolouration. Blanching of colocasia leaves in water for 10 seconds or in alkali like sodium bicarbonate @ 0.1% resulted in superior product which unlike the steam blanched or unblanched leaves by showing minimal loss of green colour as reflected in chlorophyll content and nutritional characteristics.

Ilelaboye et al., (2013) studied the effect of cooking methods on the mineral contents and anti nutritional components of the seven tropical leafy vegetables. There is varietal influence on the mineral and anti nutritional contents of the vegetables. All the mineral elements; calcium, phosphorus, potassium, magnesium, iron, manganese, copper and zinc, except sodium (155.14mg/Kg to 4759.80mg/Kg) were reduced by the cooking methods. There
was 45.96% to 69.33%, 39.22% to 64.42%, 76.71% to 87.88%, 68.10% to 98.33% and 78.78% to 88.02% reduction in phytate, oxalate, saponin, tannin and cyanide contents of the vegetables respectively due to cooking methods.

Ankit and Prasad (2013) reported that dehydration temperature of 60°C for unblanched and 70°C for blanched spinach could be used for production of enhanced quality green leafy vegetable powder of wider acceptability.

Satwase et al., (2013) studied the drying technique viz. sun drying, shadow drying, cabinet drying and oven drying of moringa oleifera. The results obtained from cabinet dried sample were better than other and it had highest nutrient retention followed by shadow, sun drying and oven dried sample. The rehydration ratio calculated at 55°C, 65°C, 75°C temperature for 60, 45, 30 minutes respectively. The rehydration ratio of cabinet dried sample was more than other samples. The study revealed that the cabinet tray drying method was observed suitable for dehydration of drumstick leaves.

Kakade et al., (2015) assessed that beetroot green is more nutritious as compared to the beetroot but in many part of India it is not used as food it is only used as animal fodder. To overcome the malnutrition problem of developing countries we can utilize beetroot green waste for products development as it is nutritionally rich in fiber, protein, carbohydrate, vitamins and minerals. The results indicate that the moisture content, chickpea powder and beetroot leaves powder had significant effect on variables like bulk density, lateral expansion, hardness and overall acceptability of extrudate prepared from cereals, chickpea and beetroot leaves powder. The study concluded that optimized extruded product is rich in crude fiber content and total phenolic content (TPC).

2.2. Studies on nutritional content of colocasia leaves

Amagloh and Nyarko (2012) assessed that leafy vegetables serve as the base of soups, a significant component of Ghanaian food recipes. In this study, the mineral content viz: calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na) and zinc (Zn) in the leaves of Hibiscus
sabdariffa, Amaranthus spinosus, Hibiscus cannabinus, Solanumma crocapon and Vigna unguiculata that are popularly used in food recipes in northern Ghana (compose of the Northern, Upper East and Upper West Regions), were compared with the mineral content in colocasia esculenta leaves. Colocasia esculenta leaves were obtained from market centres in Ashanti Region (forest zone). The leaves were shredded and air-dried for 7 days. The dried leaves were ground and analysed for the mineral content using Instrumental Neutron Activation Analysis. The Ca content of Hibiscus sabdariffa was significantly higher than that of Colocasia esculenta by 1.07-fold difference (p<0.05). However, compared with Amaranthus spinosus, Hibiscus cannabinus, Solanumma crocapon and Vigna unguiculata, the level of Ca in the Colocasia esculenta leaf was (significantly higher p<0.05) 1.23- to 1.84- fold. The Fe level in the leafy vegetables commonly consumed in northern Ghana was significantly lower (2.92- to 70.60-fold difference, p<0.0001) compared with the Colocasia esculenta leaf. Significant differences (p<0.05) were also observed in the content of K, Mg and Zn between the other greens studied and the Colocasia esculenta leaf. The difference was between 1.17- to 1.48- folds (K), 1.08- to 1.54- folds (Mg) and 1.15- to 2.59- folds (Zn)

Wani and Sood (2014) studied that cauliflower leaves are rich in β-carotene and iron. Therefore, an attempt was made to utilize its leaves in value added product, thus reducing the wastage. The highest moisture, crude protein, crude fibre and ash content of 1.68, 9.49, 13.32 and 1.49% were recorded in biscuits prepared with 70:30: malted wheat flour: cauliflower leaf powder.

Yirankinyuki et al., (2013) studied the proximate and mineral analysis of colocasia leaves. The moisture content was 8.00%, ash 10.00%, crude lipid 4.5%, crude fiber 1.00%, crude protein 5.57%, carbohydrate 78.93% and the energy value was 378.5kcal. The high potassium content and high carbohydrate content showed that colocasia leaves could be a good source of potassium for the elderly people with nerves problem and a source of energy when eaten with low energy food.
Srinivasamurthy et al., (2017) studied that Moringa oleifera are one such source which holds great promise. The product optimization with different concentrations of dried MOLP was done on the basis of preliminary (5%, 10% and 15%) and final (8%, 10% and 12%) sensory analysis (colour & appearance, odor, texture, flavor and overall acceptability) with 9-point hedonic scale. The results concluded that muffin with 12% concentration was most preferred. The physicochemical and functional tests of optimized moringa muffin depicted a significant increase (p<0.05) in moisture (17.67%), ash (1.63%), protein (7.5g/100g), fat (15.04g/100g), iron (3.55mg/100g), calcium (55.06mg/100g), potassium (111.03mg/100g), beta carotene (12.999mg/100g) and vitamin C (37.5mg/100g) than the control muffin.

2.3. Studies on anti-nutritional content of colocasia leaves

Oscarsson and Savage (2007) studied that colocasia is a major staple food crop in parts of Asia and the Pacific Islands and is grown as a minor crop in New Zealand. Soluble oxalates were 74% of the total oxalate content of the young and old leaves. Oxalate analysis was also carried out on leaves baked at 150°C for 1.5 h either alone or with 50 ml cow’s milk. The soluble oxalate content of the fresh baked tissue fell to a mean of 59% for both samples of leaves. Baking the young and old leaves with milk led to a further reduction of the soluble oxalate content in the cooked leaves (mean 21.4% of the total oxalates). The results from this study suggest that baked colocasia leaves should be regarded as a high oxalate food but baking with milk significantly reduces the amount of soluble oxalate that could be absorbed from the cooked leaves.

Lewu et al., (2009) investigated the effect of cooking on the mineral and antinutrient contents of the leaves of seven varieties of colocasia esculenta. Boiling for 5 min led to 16-78% drop in oxalate level, 28 - 61% in tannin and 17 - 41% reduction in phytate contents.

Damilola et al., (2013) investigated chemical composition of red and white cocoyam leaves. Standard methods were employed to analyze red and
white cocoyam leaves for proximate, mineral and anti-nutrients compositions. Qualitative and quantitative analysis of phytochemicals were also carried out to ascertain their presence and relative abundance in the samples. These analyses showed that the samples possess high ash content, hence, appreciable mineral content. The samples were also found to have large amounts of anti-nutrients; phytate and oxalates. Qualitative and quantitative analyses for phytochemicals confirmed the presence of bioactive constituents like tannins, flavonoids, total phenols and alkaloids in various proportions.

Odedeji et al., (2014) studied that nutritional and antinutritional compositions of raw and blanched colocasia leaves. The leaves were divided into two parts; one was blanched at 80°C for 5mins and the other used on raw basis. Nutritional analysis results reveals that the raw and blanched samples in % contained 88.5 and 76.9 moisture, 2.7 and 8.4 protein, 0.4 and 0.5 fat, 2.5 and 3.1 ash, 2.8 and 2.7 crude fibre, 3.1 and 8.4 carbohydrate, 15(mg/100g) and 8mg/100g Vitamin C, while the carotene values were 16mg/100 and 22mg/100 respectively. Organoleptic analysis results revealed that there was no significant difference among the sample in term of all the parameters evaluated since F-calculated values were smaller than Q-factor (3.01) at 5% significant level. This therefore presents the leaves of colocasia esculenta as a good dietary supplement.

Melese and Negussie (2015) investigated that leaves of colocasia esculanta are rich in nutrients, including minerals such as calcium, phosphorus, iron and vitamins like vitamin-C, thiamine, riboflavin and niacin.

Melese et al., (2016) studied that nutritive and non-nutritive constituents of colocasialeaf powder and leaf curd extracts through improved processing methods. The analysis undertaken in this study was leaf proximate composition, mineral concentration and anti-nutritional factors of samples processed as leaf powder and curd concentrates between local colocasia and boloso-1 colocasia varieties. The five macro minerals, mg/100 g of Na, K, Mg, P and Ca in the study differ significantly and ranged from lowest (6.607 ±
1.055, 14.333 ± 1.470, 8.293 ± 1.899, 1.179 ± 0.81 and 15.265 ± 6.211 respectively) to highest (7.826 ± 1.827, 17.017 ± 3.4, 9.744 ± 1.908, 1.904 ± 0.995 and 19.547 ± 6.69) value, respectively. Most of the analyzed samples that boloso-1 taro variety subjected to curd processing provided better proximate, mineral, functional and lower anti-nutritional contents than that of the local colocasia leaf.

Hang et al., (2017) investigated oxalate content of colocasia leaves grown in central Vietnam. The total oxalate content of the leaves ranged from 433.8 to 856.1 mg/100g while the soluble oxalate ranged from 147.8 to 339.7 mg/100g. The proportion of soluble oxalate ranged from 28% to 41% of the total oxalate content of the leaves. The equivalent insoluble oxalate proportion ranged from 59% to 72% of the total. There was little difference between the Colocasiaesculenta and Alocasiaodora rataro cultivars, although the total oxalate content was significantly higher in Alocasiaodora cultivars. The overall mean total calcium content was 279.5 mg/100 and the percentage of insoluble calcium bound as calcium oxalate ranged from 31.7% to 57.3% of the total calcium content.

2.4. Studies on development of food products with incorporation of fresh and dry colocasia leaves

Singh and sharma (2003) assessed that traditionally, the colocasia leaf rolls were prepared with cereal flours such as maize and rice. As these cereals are poor in quality and quantity protein, an attempt was made to supplement the colocasia leaf rolls with different protein sources such as soybean, black gram and bengal gram to improve the product nutritionally. Results suggested that rolls prepared with legumes were nutritionally and organoleptically superior to the rolls prepared with cereals.

Akoja (2016) studied that ‘Koroko’ a local maize snack was prepared from maize-cocoyam leaf shoot flour mixture in ratio of 100:0, 99:1, 97:3, 95:5, 93:7 & 91:9. The blends were made into a thick paste, manually shaped into a ring shape and deep fried in hot vegetable oil for 5 min. Results obtained
indicated substantial increase in the level of protein, fat and fibre with an increase in the level of substitution with cocoyam leaf shoot. The carbohydrate content decreases as the proportion of colocasia leaf shoot flour increases ranging from 65.6% to 46.88%.

Gupta and Prakash (2011) investigated micronutrient rich products with dried greens. ‘Keerae’ (Amaranthus paniculatus) and ‘shepu’ (Peucedanum graveolens) greens were steam blanched after chemical pretreatment and dried in hot air oven. Dried greens were analyzed for proximate constituents, vitamins, minerals, antinutrients and dialyzable minerals. Dehydrated greens were incorporated into ‘Mathri’ – a wheat flour based deep fried product and ‘Thalipeeth’ – a mixed cereal based shallow fried product at 4, 8 and 12 % levels. The products were evaluated for sensory quality in comparison to control (without greens) by an untrained panel numbering 80. Analysis of chemical composition showed no significant losses in proximate, mineral and antinutrient contents of dehydrated greens. Results of sensory analysis revealed that products incorporated with 4% dehydrated greens were similar to control in texture, taste and overall quality. However, acceptability scores reduced with increasing concentration of greens. Addition of dehydrated greens increased nutrient density of all products.

Wani et al., (2013) studied that effects of supplementation of wheat flour with dried cauliflower leaves were studied for nutritional and organoleptic quality of noodles. The malted wheat flour was blended with cauliflower leaf powder in the ratio’s of 100:0, 90:10, 80:20 and 70:30 separately for the development of noodles. The developed product was stored for 90 days to ascertain the changes in physico-chemical and sensory characteristics. The result obtained in this study suggested that acceptable noodles in terms of physicochemical and sensory properties could be produced by incorporating cauliflower leaf powder into malted wheat flour upto the level of 10 per cent flour weight basis. Thus, cauliflower leaf powder could be successfully used to
enrich noodles, giving alternative utilization opportunity to producers and healthy choice option to the consumers.

Chauhan and Intelli (2014) developed low cost fiber rich products for people suffering from micronutrient deficiency and to assess the sensory quality of developed products. The fresh collected cauliflower green leaves were washed and sun dried for 5-7 days to dry them. Three recipes (pancake, dhokla and idli) were supplemented with 2g and 5g dried cauliflower green leaves powder (DCGLP) per serving and sensory evaluation was done with the help of 9 point hedonic rating scale in reference to appearance, taste, texture and flavour by 9 panels of semi trained judges. Biochemical analysis of DCGLP revealed moisture 3.4 percent, protein 21.6 percent, crude fiber 10.23gm and iron 62mg (values as per 100gm). The prepared recipes were found to be acceptable at 2 g incorporation of DCGLP. It was concluded that increase in the incorporation of DCGLP in recipes was decreasing acceptability. DCGLP, due to its high iron content can be used as supplement to make low cost iron rich recipes.

Haneen Hamed (2015) study on incorporation of dried *moringa oleifera* leaves powder (DMLP) at different levels (5, 10 and 15 %) in cookies the sensory and nutritional properties were evaluated. The results revealed that the content of protein, dietary fiber, minerals in cookies increased with incorporation of increasing levels of DMLP. Sensory evaluation showed that cookies with acceptable quality and typical *moringa* leaf flavor could be obtained by incorporating DMLP up to 10 %. Thus, the nutritional quality of cookies could be enhanced by incorporating DMLP in a dose dependent manner.

Melese et al., (2017) studied that colocasia leaf is rich in proteins and can be of supplementary protein, carotene and trace minerals in chicken diets. Colocasia leaf meal is cost effective meal when used as replacement of expensive and conventional meal in broilers rations.
Anju Rani et al., (2017) studied that “Organoleptic evaluation of dried colocasia leaf powder incorporated in “gate ki sabji and mathari”. In the present study dried colocasia leaf powder was incorporated in different ratios in gatte ki Sabji (4%, 5% and 6%) and mathari (5%, 7% and 10%). On the basis of scores two most acceptable recipes of gate ki sabji (4% dried colocasia leaf powder incorporated) and ‘mathari’ (5% dried colocasia leaf powder incorporated) from all the samples were selected and their nutritive value was calculated. The nutrient calculation showed a good increase in calcium with the incorporation of dried colocasia leaf powder as compared to standard recipe. On the basis of scores 5% dried colocasia leaf powder incorporated mathari was most acceptable. It was concluded that dried colocasia leaf powder could be successfully incorporated in recipes as it is a very good source of calcium and could be very beneficial for women having calcium deficiency.
CHAPTER 3

MATERIALS AND METHODS

The present investigation was carried out in two phases. In first phase of the study, different value added food products like colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves, Bengal gram chutney with colocasia leaves, colocasia puri, colocasia dhokla, colocasia kharapara and colocasia varan were prepared and standardized by incorporation of fresh and dried colocasia leaves powder. The prepared products were evaluated to find out the most suitable and highly accepted level of incorporation. In the second phase of the study, the most accepted products were assessed for their nutrient content and were stored to evaluate the shelf life. The details of the methodology followed and materials used in the present study are described here under.

3.1 Procurement and Processing of Raw Material

The colocasia leaves were purchased, cleaned and washed with water. For preparation of products with incorporation of fresh colocasia leaves, the leaves were boiled for 2 min in water and products were prepared. For the preparation of products with incorporation of dry colocasia leaves powder, the leaves were blanched, dried, powdered with grinder and sieved. This powder was used for preparation of products. 4 recipes with 4 variations were prepared by fresh colocasia leaves and 4 recipes with 4 variations were prepared by dried colocasia leaves powder. The basic recipe was prepared for each value added product. Colocasia powder was stored in air tight container for development of recipes and chemical analysis.

3.2 Selection of Food Products

Colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves, bengal gram chutney with colocasia leaves were prepared with incorporation fresh colocasia leaves.
Fig. 1. Experimental design of research work

**Experimental Design**

**Fresh colocasia leaves**
- Boiled
  - Incorporation in Products
    - Colocasia dhapata
    - Colocasia a masala vada
    - Coconut chutney with colocasia leaves
    - Bengal gram chutey with colocasia

**Dry colocasia leaves**
- Blanched
- Dried
- Powdered
  - Incorporation in Products
    - Colocasia dhokla
    - Colocasia kharapara
    - Colocasia puri
    - Colocasia varan
Colocasia puri, colocasia dhokla, colocasia kharapara and colocasia varan were prepared with incorporation of dried colocasia leaves powder.

3.3 Preparation of Products

Colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves, bengal gram chutney with colocasia leaves, were prepared with incorporation of fresh colocasia leaves. Five variations of each product were prepared for organoleptic evaluation. Variation one was basic recipe which was prepared without incorporation of fresh colocasia leaves and it served as control. Variations II to V were experimental variations with varying levels of incorporation of fresh colocasia leaves.

Colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves, bengal gram chutney with colocasia leaves, coconut chutney with colocasia leaves were prepared in five variations with powdered colocasia leaves. Variation one was basic recipe which was prepared without incorporation of dry colocasia leaves powder and used as basic. Variations II to V were experimental variations with varying levels of incorporation of dry colocasia leaves powder. The ingredients used and the procedures followed for the preparation of selected food products are given in Appendix I.

3.4 Organoleptic Evaluation of Prepared Products

The organoleptic evaluation of prepared food products was conducted to find out the maximum level of incorporation of fresh and dried colocasia in the selected food products (Amerine et al., 1965).

3.4.1 Selection of Panel Members

The sensory threshold test was carried out on 20 members to select panel members. Different solutions of sugar and salt with different concentrations for threshold test were prepared as described by Ranganna (1979) and the members were requested to evaluate the solutions for strength of different tastes. Considering the accuracy in evaluation of taste,
15 panel members were selected out of 20 to act as judges for sensory evaluation of products.

**3.4.2 Sensory Evaluation**

The selected food products were prepared with different levels of incorporation of fresh and dried colocsia leaves. All the selected panel members were requested to evaluate the developed food products. The judges were requested to score the recipes for different sensory characters namely colour, texture, taste, flavour and overall acceptability by using Five Point Ranking Scale in which point 5 represent excellent, 4 represent very good, 3 represent good, 2 represent fair and 1 represent poor (Amerine et al., 1965) (Appendix – II). Highly accepted variations were selected for nutritional analysis and shelf life study.

**3.5 Nutrient Analysis**

The most accepted variation of all the selected food products was subjected to chemical analysis in the laboratory. Various parameters considered for nutrient analysis were moisture, protein, fat, total minerals, fibre, calcium, iron, zinc, magnesium and copper were estimated.

The proximate composition was carried out as per procedures prescribed by A.O.A.C., (1984) method. Protein was estimated by macro kjeldhal method. Carbohydrate content was computed by Gopalan et al, (1989). The calcium was estimated by EDTA (Ethylene diamine tetra acetic acid) method. The trace elements, Iron, zinc, magnesium, and copper were estimated by atomic absorption spectrophotometer. The analysis was carried out by the sample moisture free (Appendix-III).

**3.6 Acceptability of Value Added Products During Storage**

**3.7 Statistical Analysis**

The collected data was consolidated, tabulated and analysed statistically. The analysis of variance was used for interpreting the
Plate 1. Analyzing mineral content

Plate 2. Analyzing fibre content
differences between different variations for individual sensory characters. The statistical difference with regard to nutrient content of developed products prepared with and without incorporation of *fresh and dried colocasia* was assessed by ‘t’ test (Gupta, 2014).
CHAPTER 4

RESULTS AND DISCUSSION

The present investigation was carried out for the development of value added products with colocasia leaves fresh and dry. The products, *colocasia dhapata*, *colocasia masala vada*, coconut chutney with colocasia leaves, bengalgram chutney with colocasia leaves, were prepared with incorporation of fresh colocasia leaves and the products like *colocasia dhokla*, *colocasia kharapara*, *colocasia puri* and *colocasia varan* were prepared with incorporation of dry colocasia leaves powder. The basic recipe was prepared for each value added product. The products were evaluated organoleptically for acceptability and analysed in the laboratory for their nutritional composition. The storage study was carried out for 5 products *colocasia dhapata*, *colocasia masala vada*, *colocasia dhokla*, *colocasia kharapara* and *colocasia puri*. These products were kept in zip lock bag and aluminium foil for varying periods. They were evaluated for sensory qualities. The data for organoleptic evaluation and nutritional analysis were formulated and analysed statistically which is discussed under the following heads in this chapter.

4.1. Organoleptic evaluation of developed products

4.2. Nutrient analysis of value added developed products

4.3. Shelf life of value added developed products

4.1. Organoleptic evaluation of developed products

4.1.1. Organoleptic evaluation of products with incorporation of fresh

*colocasia leaves*

4.1.1.1. Organoleptic evaluation of *colocasia dhapata*

*Colocasia dhapata* (Plate 3) was prepared by incorporating fresh colocasia leaves at different levels (7 to 10 per cent) and was evaluated for sensory characteristics. The related data about sensory scores are given in Table 1 and represented in Fig.2.
The mean scores for colour obtained by colocasia *dhapata* with 0, 7, 8, 9 and 10 per cent of fresh colocasia leaves incorporation were 4.5, 4.3, 4.4, 4.6 and 4.8 respectively. The maximum score (4.8) was obtained by 10 per cent level of colocasia leaves incorporation and minimum score (4.3) was obtained by 7 per cent incorporation. As the level of incorporation was increasing the score was decreasing. Statistical analysis showed that, the scores obtained for colour of colocasia *dhapata* differed significantly. From the findings it can be said that 10 per cent level of incorporation of fresh colocasia leaves was found to be most accepted.

The mean scores of texture of colocasia *dhapata* with 0, 7, 8, 9 and 10 per cent level of incorporation fresh colocasia leaves were 5.0, 4.6, 4.6, 4.8 and 3.9 respectively. In case of texture the basic variation i.e. without incorporation of colocasi leaves recorded maximum score (5.0). The score obtained for colocasia *dhapata* with 7, 8, 9 and 10 per cent level of fresh colocasia leaves incorporation differed significantly.

The mean score secured for taste was ranging from 4.6 to 5.0. The highest score (5.0) for taste was secured by 10 per cent level of colocasia leaves incorporation while the minimum score was 4.6 which was allotted for 0, 7, 8 and 9 per cent incorporation. The incorporation of 10 percent colocasia leaves recorded maximum score for taste.

The score for the flavour of colocasia *dhapata* with 0, 7, 8, 9, and 10 per cent level of incorporation of colocasia leaves ranged from 4.5 to 4.8. The highest scores of 4.8 for flavor was recorded by colocasia *dhapata* prepared with 10 per cent level of incorporation of fresh colocasia leaves. Statistical analysis showed that difference was significant. On the whole, it was inferred that 10 per cent level of incorporation of colocasia leaves in colocasia *dhapata* was considered as most suitable level.

The mean scores for overall acceptability of colocasia *dhapata* with 0, 7, 8, 9 and 10 per cent level of incorporation of fresh colocasia leaves were 4.5, 4.5, 4.6, 4.8, and 4.8. The highest score (4.8) for the overall acceptability was
secured by 10 per cent level of incorporation of colocasia leaves * colocasia _dhapata_ while the minimum score was 4.5 at 7 per cent level of incorporation of colocasia leaves. Statistical analysis indicated that scores obtained by colocasia _dhapata_ at various levels of incorporation of colocasia leaves differed significantly. Hence, it is concluded that addition of colocasia leaves up to 10 per cent level in colocasia _dhapata_ was well accepted by panel members.

Table 1. Organoleptic evaluation scores of _colocasia dhapata_

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------------------------------------------|--------|---------|-------|---------|----------------------|
| Basic      | 0                                          | 4.5    | 5.0     | 4.6   | 4.7     | 4.5                  |
| I          | 7                                          | 4.3    | 4.6     | 4.6   | 4.6     | 4.5                  |
| II         | 8                                          | 4.4    | 4.6     | 4.6   | 4.6     | 4.6                  |
| III        | 9                                          | 4.6    | 4.8     | 4.7   | 4.5     | 4.8                  |
| IV         | 10                                         | 4.8    | 3.9     | 5.0   | 4.8     | 4.8                  |
| CD         | 0.2                                        | 0.2    | 0.2     | 0.1   | 0.1     | 0.1                  |
| SE±        | 0.1                                        | 0.1    | 0.08    | 0.04  | 0.06    |                      |
| F-value    | 2.8*                                       | 15.3** | 3.6*    | 3.3*  | 3.1*    |                      |

NS: Non significant   *Significant at 5 per cent   **Significant at 1 per cent

4.1.1.2 Organoleptic evaluation of _colocasia masala vada_

The mean value of organoleptic scores for the acceptability of colocasia _masala vada_ prepared with and without incorporation of colocasia leaves (Plate 4) are given in Table 2 and represented in Fig. 3.

The mean scores for colour of colocasia _masala vada_ with 0, 7, 8, 9 and 10 per cent level of incorporation of colocasia leaves were 4.7, 4.4, 4.4, 4.8 and 4.8 respectively. The highest score (4.8) for the colour was secured by 9 and 10 per cent level of incorporation of colocasia leaves in colocasia _masala vada_ while the minimum score was 4.4 at 7 and 8 per cent level of incorporation of colocasia leaves. Statistical analysis indicated that scores obtained by colocasia _masala wada_ at various levels of incorporation of fresh colocasia leaves differed significantly.
Fig. 1 Organoleptic evaluation scores of colocasia *dhapata*

**Variations**

- Basic (0%)
- I (7%)
- II (8%)
- III (9%)
- IV (10%)

**Organoleptic characteristics**

**Fig. 1** Organoleptic evaluation scores of colocasia *dhapata*
The mean scores for texture obtained by colocasia *masala vada* with 0, 7, 8, 9 and 10 per cent of fresh colocasia leaves incorporation were 4.9, 4.6, 4.6, 4.8 and 4.8 respectively. The maximum score (4.9) was obtained by 0 per cent level of fresh colocasia leaves incorporation and minimum score (4.6) was obtained by 7 and 8 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of colocasia *masala wada* differed significantly.

The mean scores of taste of colocasia *masala vada* with 0, 7, 8, 9 and 10 per cent level of incorporation of fresh colocasia leaves were ranging from 4.6 to 4.7. In case of colour, texture, flavour and overall acceptability the maximum score was obtained by 10 per cent level of incorporation of fresh colocasia leaves.

The mean score secured for flavour was ranging from 4.5 to 4.8. The highest score (4.8) for flavour was secured by 0 and 10 per cent level of colocasia leaves incorporation while the minimum score was 4.5 which was allotted for 9 per cent incorporation. The result showed that the flavour for colocasia masala vada at 0, 7, 8, 9 and 10 per cent level of incorporation of colocasia leaves was significantly different.

Score registered for the overall acceptability of colocasia *masala vada* with 0, 7, 8, 9, and 10 per cent level of incorporation of colocasia leaves were between 4.5 to 4.8. The highest scores of 4.8 for overall acceptability was recorded by colocasia *masala wada* prepared with 9 and 10 per cent level of incorporation of fresh colocasia leaves. Statistical analysis showed that difference was significant. On the whole, it was inferred that 10 per cent level of incorporation of colocasia leaves in colocasia *masala wada* was considered as most suitable level. Hence, it was concluded that addition of colocasia leaves up to 10 per cent level in colocasia *masala wada* was well accepted by panel members.
Table 2. Organoleptic evaluation scores of *colocasia masala wada*

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|-------------------------------------------|--------|---------|-------|---------|----------------------|
| Basic      | 0                                          | 4.7    | 4.9     | 4.7   | 4.8     | 4.5                  |
| I          | 7                                          | 4.4    | 4.6     | 4.6   | 4.6     | 4.5                  |
| II         | 8                                          | 4.4    | 4.6     | 4.6   | 4.6     | 4.6                  |
| III        | 9                                          | 4.8    | 4.8     | 4.8   | 4.8     | 4.8                  |
| IV         | 10                                         | 4.8    | 4.8     | 4.6   | 4.8     | 4.8                  |
| CD         | 0.3                                        | 0.2    | 0.1     | 0.2   | 0.2     | 0.2                  |
| SE±        | 0.1                                        | 0.08   | 0.05    | 0.07  | 0.08    | 0.08                 |
| F-value    | 3.2*                                       | 2.6*   | 3.0*    | 2.7*  | 2.8*    | 2.8*                 |

NS: Non significant  *Significant at 5 per cent       **Significant at 1 per cent

4.1.1.3. Organoleptic evaluation of coconut chutney with colocasia leaves

Coconut chutney with colocasia leaves (Plate 5) was prepared by incorporating fresh colocasia leaves at different level (7 to 10 per cent) and was evaluated for sensory characteristics. The related data about sensory scores are given in Table 3 and represented in Fig.4.

The mean scores for colour obtained by coconut chutney with colocasia leaves 0, 7, 8, 9 and 10 per cent of fresh colocasia leaves incorporation were ranging from 3.5 to 4.4 respectively. The maximum score (4.4) was obtained by 10 per cent level of colocasia leaves incorporation and minimum score (3.5) was obtained by 8 per cent incorporation.

The scores obtained for texture were ranging from 4.2 to 4.4. The maximum score (4.4) for texture was obtained by incorporation of 10 per cent fresh colocasia leaves and the minimum score was (4.2) with incorporation of 7 per cent fresh colocasia leaves.

Mean score for taste by coconut chutney with colocasia leaves were ranging from 3.4 to 4.6 maximum score was obtained by (4.6) was obtained by incorporation of 10 per cent fresh colocasia leaves and the minimum score (3.4) was for incorporation of 8 per cent colocasia leaves.
Fig. 2. Organoleptic evaluation scores of *colocasia masala vada*

Variations

| Basic (0%) | I (7%) | II (8%) | III (9%) | IV (10%) |
|------------|--------|---------|----------|----------|

| Score | Colour | Texture | Taste | Flavour | Overall acceptability |
|-------|--------|---------|-------|---------|-----------------------|
| 4.5   | 4.5    | 4.5     | 4.5   | 4.5     | 4.5                   |
| 4.0   | 4.0    | 4.0     | 4.0   | 4.0     | 4.0                   |
| 3.5   | 3.5    | 3.5     | 3.5   | 3.5     | 3.5                   |
| 3.0   | 3.0    | 3.0     | 3.0   | 3.0     | 3.0                   |
| 2.5   | 2.5    | 2.5     | 2.5   | 2.5     | 2.5                   |
| 2.0   | 2.0    | 2.0     | 2.0   | 2.0     | 2.0                   |
| 1.5   | 1.5    | 1.5     | 1.5   | 1.5     | 1.5                   |
| 1.0   | 1.0    | 1.0     | 1.0   | 1.0     | 1.0                   |
| 0.5   | 0.5    | 0.5     | 0.5   | 0.5     | 0.5                   |
| 0.0   | 0.0    | 0.0     | 0.0   | 0.0     | 0.0                   |
Plate 3. *Colocasia dhopata* prepared with incorporation of fresh colocasia leaves

Plate 4. *Colocasia masala vada* prepared with incorporation of fresh colocasia leaves
The mean scores for flavour obtained by coconut chutney with colocasia leaves were ranging from 3.4 to 4.2 the minimum score (3.4) was obtained by incorporation of 8 per cent fresh colocasia leaves, whereas the maximum score (4.2) was obtained by incorporation of 10 per cent fresh colocasia leaves.

The mean scores for overall acceptability of coconut chutney with colocasia leaves were ranging from 3.4 to 4.6 the minimum score (3.4) was obtained by 8 per cent incorporation of fresh colocasia leaves and the maximum (4.6) was obtained by 10 per incorporation fresh colocasia leaves in coconut chutney recorded highest score in colour, texture, taste, flavour and over all acceptability. The results were significant at 5 per cent and 1 per cent. It can be concluded from the result that incorporation of 10 per cent colocasia leaves in coconut chutney was highly accepted.

Table 3. Organoleptic evaluation scores of coconut chutney with colocasia leaves

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------------------------------------------|--------|---------|-------|---------|-----------------------|
| Basic      | 0                                          | 3.8    | 4.2     | 3.6   | 3.8     | 3.6                   |
| I          | 7                                          | 4.2    | 4.2     | 3.7   | 3.6     | 3.6                   |
| II         | 8                                          | 3.5    | 4.3     | 3.4   | 3.4     | 3.4                   |
| III        | 9                                          | 4.0    | 4.3     | 3.6   | 3.8     | 3.8                   |
| IV         | 10                                         | 4.4    | 4.4     | 4.6   | 4.2     | 4.6                   |
| CD         |                                             | 0.6    | 0.05    | 0.6   | 0.3     | 0.6                   |
| SE±        |                                             | 0.2    | 0.01    | 0.2   | 0.1     | 0.2                   |
| F-value    |                                             | 2.8*   | 2.9*    | 3.5*  | 4.3**   | 4.2**                 |

NS: Non significant *Significant at 5 per cent **Significant at 1 per cent

4.1.1.4. Organoleptic evaluation of bengalgram chutney with colocasia leaves

The mean value of organoleptic scores for the acceptability of bengalgram chutney with colocasia prepared with and without incorporation of fresh colocasia leaves (Plate 6) are given in Table 4 and represented in Fig. 5.
The mean scores of colour of bengalgram chutney with colocasia leaves 0, 7, 8, 9 and 10 per cent level of incorporation fresh colocasia leaves were 3.4, 4.1, 4.3, 4.7 and 5.0 respectively. The bengalgram chutney with colocasia leaves prepared with 10 per cent level of incorporation recorded maximum score (5.0) while lowest score (3.4) was recorded for 0 per cent level of incorporation. The score obtained for bengalgram chutney with colocasia at 10 per cent level of fresh colocasia leaves incorporation differed significantly. On the whole it can be said that the colour of bengalgram chutney with colocasia leaves 10 per cent level of incorporation of fresh colocasia leaves was accepted.

The mean scores for texture obtained by colocasia bengalgram chutney with colocasia with 0, 7, 8, 9 and 10 per cent of fresh colocasia leaves incorporation were 4.6, 4.4, 4.6, 4.8 and 4.9 respectively. As the maximum score (4.9) was obtained by 10 per cent level of colocasia leaves incorporation and minimum score (4.4) was obtained by 7 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of bengalgram chutney with colocasia differed significantly. From the finding it can be said that 10 per cent level of incorporation of colocasia leaves was found to be most accepted.

The mean score secured for taste was ranging from 2.8 to 3.8. The highest score (3.8) for taste was secured by 10 per cent level of colocasia leaves incorporation while the minimum score was 2.8 which was allotted for 0 per cent incorporation. The result showed that the taste for colocasia bengalgram chutney with colocasia at 0, 7, 8, 9 and 10 per cent level of incorporation of colocasia leaves was significantly different.

Score registered for the flavour of bengalgram chutney with colocasialeaves with were 0, 7, 8, 9 and 10 per cent level of incorporation of colocasia leaves were between 3.0 to 4.2. The highest score of 4.2 for flavour was recorded by bengalgram chutney with colocasia leaves prepared with 10 per cent level of incorporation of colocasia leaves. Statistical analysis showed that difference was significant. On the whole, it was inferred that 10 per cent
Fig. 3. Organoleptic evaluation scores of coconut chutney with colocasia leaves
level of incorporation of colocasia leaves in bengalgram chutney with colocasia leaves was considered as most suitable level.

The mean scores for overall acceptability of bengalgram chutney with colocasia leaves with 0, 7, 8, 9 and 10 per cent level of incorporation of colocasia leaves were 3.1, 3.4, 3.6, 4.3 and 4.3 respectively. Statistical analysis indicated that scores obtained by bengalgram chutney with colocasia leaves at various levels of incorporation of colocasia leaves differed significantly. The highest score (4.3) for the overall acceptability was secured by 9 and 10 per cent level of incorporation of colocasia leaves in bengalgram chutney with colocasia while the minimum score was 3.1 at 0 per cent level of incorporation of colocasia leaves. Hence, it is concluded that addition of colocasia leaves up to 10 per cent level in bengalgram chutney with colocasia leaves was well accepted by panel members.

Table 4. Organoleptic evaluation scores of bengal gram chutney with colocasia leaves

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|-------------------------------------------|--------|---------|-------|---------|-----------------------|
| Basic      | 0                                          | 3.4    | 4.6     | 2.8   | 3.0     | 3.1                   |
| I          | 7                                          | 4.1    | 4.4     | 3.0   | 3.6     | 3.4                   |
| II         | 8                                          | 4.3    | 4.6     | 3.4   | 3.9     | 3.6                   |
| III        | 9                                          | 4.7    | 4.8     | 3.6   | 4.2     | 4.3                   |
| IV         | 10                                         | 5.0    | 4.9     | 3.8   | 4.2     | 4.3                   |
| CD         | 0.3                                        | 0.3    | 0.5     | 0.4   | 0.5     |                       |
| SE±        | 0.1                                        | 0.1    | 0.2     | 0.1   | 0.1     |                       |
| F-value    | 16.8**                                     | 6.6**  | 4.4**   | 10.1**| 8.0**   |                       |

NS: Non significant   *Significant at 5 per cent           **Significant at 1 per cent
Fig. 4. Organoleptic evaluation scores of bengal gram chutney with colocasia leaves.
Plate 5. Coconut chutney with colocasia leaves prepared with incorporation of fresh colocasia leaves

Plate 6. Bengalgram chutney with colocasia leaves prepared with incorporation of fresh colocasia leaves
4.1.2. Organoleptic evaluation of products with incorporation of dry colocasia leaves powder

4.1.2.1. Organoleptic evaluation of colocasia dhokla

The mean values of organoleptic scores for the acceptability of colocasia dhokla prepared with and without incorporation of dry colocasia leaves powder (Plate 7) are given in Table 5 and represented in Fig. 6.

The mean scores of colour of colocasia dhokla with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were 4.1, 3.4, 4.4, 4.9 and 4.7 respectively. The colocasia dhokla prepared with 6 per cent level of incorporation recorded maximum scores (4.9) while lowest score (3.4) was recorded for 4 per cent level of incorporation. The scores obtained for colocasia dhokla with 4, 5, 6 and 7 per cent level of dry colocasia leaves powder incorporation differed significantly. On the whole, it can be said that the colour of colocasia dhokla with 6 per cent level of incorporation of dry colocasia leaves powder was accepted.

The mean scores for texture obtained by colocasia dhokla with 0, 4, 5, 6 and 7 per cent level of dry colocasia leaves powder incorporation were 4.3, 3.4, 4.0, 4.5 and 3.0 respectively. The maximum score (4.5) was obtained by 6 per cent level of dry colocasia leaves powder incorporation and minimum score (3.4) was obtained by 4 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of colocasia dhokla differed significantly. From the finding it can be said that 6 per cent level of incorporation of dry colocasia leaves powder was found to be most accepted.

The mean scores secured for taste were ranging from 4.2 to 4.9. The highest score (4.9) for taste was secured by 6 per cent level of dry colocasia leaves powder incorporation while the minimum score was for 5 and 7 per cent incorporation. The result showed that the taste for colocasia dhokla at 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia powder was significantly different.
Scores registered for the flavour of colocasia *dhokla* with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder between were 3.7 to 4.9. The highest score of 4.9 for flavour was recorded by colocasia *dhokla* prepared with 6 per cent level of incorporation of dry colocasia leaves powder. Statistical analysis showed that difference was significant. On the whole, it was inferred that 6 per cent level of incorporation of dry colocasia leaves powder in colocasia *dhokla* was considered as most suitable level.

The mean scores for overall acceptability of colocasia *dhokla* with 0, 4, 5, 6 and 7 per cent level of incorporation dry colocasia leaves powder 3.6, 4.2, 3.3, 4.7, and 4.1 respectively. Statistical analysis indicated that scores obtained by colocasia dhokla at various levels of incorporation of dry colocasia leaves powder differed significantly. The highest score (4.7) for the overall acceptability was secured by 6 per cent level of incorporation of dry colocasia leaves powder in colocasia *dhokla* while the minimum score was 3.3 at 5 per cent level of incorporation of dry colocasia leaves powder. Hence, it is concluded that addition of dry colocasia leaves powder up to 6 per cent level in colocasia *dhokla* was well accepted by panel members.

**Table 5. Organoleptic evaluation scores of colocasia dhokla**

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------------------------------------------|--------|---------|-------|---------|----------------------|
| Basic      | 0                                          | 4.1    | 4.3     | 4.4   | 3.7     | 3.6                  |
| I          | 4                                          | 3.4    | 3.4     | 4.6   | 4.4     | 4.2                  |
| II         | 5                                          | 4.4    | 4.0     | 4.2   | 4.1     | 3.3                  |
| III        | 6                                          | 4.9    | 4.5     | 4.9   | 4.9     | 4.7                  |
| IV         | 7                                          | 4.7    | 3.0     | 4.2   | 3.8     | 4.1                  |
| CD         |                                             | 0.3    | 0.4     | 0.4   | 0.4     | 0.4                  |
| SE±        |                                             | 0.1    | 0.1     | 0.1   | 0.1     | 0.1                  |
| F-value    |                                             | 22.4** | 12.2**  | 4.1** | 10.1**  | 9.8**               |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent
Fig. 5. Organoleptic evaluation scores of *colocasia dhokla*
4.1.2.2. Organoleptic evaluation of colocasia *kharapara*

The mean scores for organoleptic characteristics of colocasia *kharapara* prepared with and without incorporation of dry colocasia leaves powder (Plate 8) are given in Table 6 and represented in Fig. 7.

Wide variations were noticed in the mean scores of colour prepared from varying different levels of incorporation of dry colocasia leaves powder. The score were ranges from 4.2 to 4.9. Highest score was 4.9 at 7 per cent of incorporation of dry colocasia leaves powder and lowest score (4.2) was recorded with incorporation of 4 and 5 per cent level in colocasia *kharapara*. Statistical analysis showed that, the scores obtained for colour of colocasia *kharapara* differed significantly. From the finding it can be said that 7 per cent level of incorporation of dry colocasia leaves powder was found to be most accepted.

The mean scores for texture obtained by colocasia *kharapara* with 0, 4, 5, 6 and 7 per cent of dry colocasia leaves powder incorporation were 4.8, 4.6, 4.6, 4.8 and 3.9. The highest score (4.8) was given to texture of 6 per cent level of dry colocasia leaves powder, was superior to other samples in terms of texture. Scores registered for the taste of colocasia *kharapara* with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were between 4.5 to 4.9. The highest score of 4.9 for taste was recorded by colocasia *kharapara* prepared with 7 per cent level of incorporation of dry colocasia leaves powder. Statistical analysis showed that difference was significant.

The mean scores for flavour obtained by colocasia *kharapara* with 0, 4, 5, 6 and 7 per cent of colocasia leaves powder incorporation were ranging 4.5 to 4.8. As the maximum score (4.8) was obtained by 10 per cent level of dry colocasia leaves powder incorporation and minimum score (4.5) was obtained by 4 and 6 per cent incorporation. Statistical analysis showed that, the scores obtained for flavour of colocasia *kharapara* differed significantly. From the findings it can be said that 7 per cent level of incorporation of dry colocasia leaves powder was found to be most accepted.
On the whole, it was inferred that 7 per cent level of incorporation of dry colocasia leaves powder in colocasia *kharapara* was considered as most suitable level.

The mean scores for overall acceptability of colocasia *kharapara* with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were 4.2, 4.5, 4.6, 4.8 and 4.8 respectively. The highest score (4.8) for the overall acceptability was secured by 7 per cent level of incorporation of colocasia leaves powder in colocasia *kharapara*. Statistical analysis indicated that scores obtained by colocasia *kharapara* at various levels of incorporation of dry colocasia leaves powder differed significantly. Hence, it is concluded that addition of colocasia leaves powder up to 6 per cent level in colocasia *kharapara* was well accepted by panel members.

On the whole, it can be said that addition of dry colocasia leaves powder up to 7 per cent in *kharapara* did not affect sensory qualities except texture.

**Table 6. Organoleptic evaluation scores of colocasia kharapara**

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------------------------------------------|--------|---------|-------|---------|---------------------|
| Basic      | 0                                          | 4.5    |         | 4.7   | 4.7     | 4.2                 |
| I          | 4                                          | 4.2    | 4.6     | 4.6   | 4.5     | 4.5                 |
| II         | 5                                          | 4.2    | 4.6     | 4.5   | 4.6     | 4.6                 |
| III        | 6                                          | 4.8    |         | 4.5   | 4.5     | **4.8**             |
| IV         | 7                                          | 4.9    | 3.9     | 4.9   | 4.8     | **4.8**             |
| CD         | 0.4                                        | 0.2    | 0.2     | 0.03  | 0.3     | NS                  |
| SE±        | 0.1                                        | 0.1    | 0.09    | 0.01  | 0.1     | NS                  |
| F-value    | **4.8**                                    | **13.6** | **2.7** | **3.0** | 4.2     | **4.2**             |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent

**4.1.2.3. Organoleptic evaluation of colocasia puri**

The mean values of organoleptic scores for the acceptability of colocasia *puri* prepared with and without incorporation of dry colocasia leaves powder (Plate 9) are given in Table 7 and represented in Fig. 8.
Fig. 6. Organoleptic evaluation scores of *colocasia kharapara*

**Variations**

| Variations | Basic (0%) | I (4%) | II (5%) | III (6%) | IV (7%) |
|------------|------------|--------|---------|----------|---------|
| (0%)       | (4%)       | (5%)   | (6%)    | (7%)     |         |

Organoleptic characteristics

**Fig. 6.** Organoleptic evaluation scores of *colocasia kharapara*
Plate 7. Colocasia dhokla prepared with incorporation of dry colocasia leaves powder

Plate 8. Colocasia kharapara prepared with incorporation of dry colocasia leaves powder
The mean scores for colour of colocasia *puri* with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were 4.4, 3.4, 4.4, 5.0 and 4.6 respectively. The highest score (5.0) for the colour was secured by 6 per cent level of incorporation of dry colocasia leaves powder in colocasia *puri* while the minimum score was 3.4 at 4 per cent level of incorporation of dry colocasia leaves powder. Statistical analysis indicated that scores obtained by colocasia *puri* at various levels of incorporation of colocasia leaves powder differed significantly.

The mean scores for texture obtained by colocasia *puri* with 0, 4, 5, 6 and 7 per cent of dry colocasia leaves powder incorporation were 4.3, 3.4, 4.0, 4.5 and 3.0 respectively. The maximum score (4.5) was obtained by 6 per cent level of colocasia leaves powder incorporation and minimum score (3.4) was obtained by 4 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of colocasia *puri* differed significantly.

The mean scores secured for flavour were ranging from 3.6 to 4.9. The highest score (4.9) for flavour was secured by 6 per cent level of dry colocasia leaves powder incorporation. The results showed that the flavour for colocasia *puri* at 0, 4, 5, 6 and 7 per cent level of incorporation of colocasia leaves powder was significantly different.

The mean scores of taste of colocasia *puri* with 0, 4, 5, 6 and 7 per cent level of incorporation dry colocasia leaves powder were ranging from 4.2 to 4.9. Scores registered for the overall acceptability of colocasia *puri* with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were ranging between 3.3 to 4.8. The highest score of 4.8 for overall acceptability was recorded by colocasia *puri* prepared with 6 per cent level of incorporation of dry colocasia leaves powder. Statistical analysis showed that difference was significant. On the whole, it was inferred that 6 per cent level of incorporation of colocasia leaves powder in colocasia *puri* was considered as most suitable level. Hence, it is concluded that addition of dry colocasia leaves powder up to 6 per cent level in colocasia *puri* was well accepted by panel members. In case
of colour, texture, flavour, taste and overall acceptability the maximum score was obtained by 6 per cent level of incorporation of dry colocasia leaves powder.

**Table 7. Organoleptic evaluation scores of colocasia puri**

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------------------------------------------|--------|---------|-------|---------|----------------------|
| Basic      | 0                                          | 4.4    | 4.3     | 4.4   | 3.6     | 3.6                  |
| I          | 4                                          | 3.4    | 3.4     | 4.6   | 4.4     | 4.0                  |
| II         | 5                                          | 4.4    | 4.0     | 4.2   | 4.1     | 3.3                  |
| III        | 6                                          | 5.0    | 4.5     | 4.9   | 4.9     | 4.8                  |
| IV         | 7                                          | 4.6    | 3.0     | 4.2   | 3.8     | 4.1                  |
| CD         |                                            | 0.3    | 0.4     | 0.4   | 0.4     | 0.4                  |
| SE±        |                                            | 0.1    | 0.1     | 0.1   | 0.1     | 0.1                  |
| F-value    |                                            | 25.3** | 12.2**  | 4.1** | 11.5**  | 12.3**               |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent

**4.1.2.4. Organoleptic evaluation of colocasia varan**

The mean values of organoleptic scores for the acceptability of colocasia varan prepared with and without incorporation of dry colocasia powder (Plate 10) are given in Table 8 and represented in Fig. 8.

The mean scores of colour of colocasia varan with 0, 4, 5, 6 and 7 per cent level of incorporation dry colocasia leaves powder were 4.6, 4.2, 4.4, 4.8 and 4.8 respectively. The colocasia varan prepared with 6 and 7 per cent level of incorporation recorded maximum scores (4.8) while lowest score (4.2) was recorded for 4 per cent level of incorporation. The score obtained for colocasia varan with 4, 5, 6 and 7 per cent level of dry colocasia leaves powder incorporation differed significantly. On the whole it can be said that the colour of colocasia varan with 6 and 7 per cent level of incorporation of dry colocasia leaves powder was accepted.

The mean scores for texture obtained by colocasia varan with 0, 4, 5, 6 and 7 per cent of dry colocasia leaves powder incorporation were 4.8, 4.6, 4.6, 4.8 and 3.9 respectively. As the maximum score (4.8) was obtained by 6 per
Fig. 7. Organoleptic evaluation scores of *colocasia puri*
cent level of colocasia leaves powder incorporation and minimum score (4.6) was obtained by 4 and 5 per cent incorporation. Statistical analysis showed that, the scores obtained for texture of colocasia varan differed significantly. From the findings it can be said that 6 per cent level of incorporation of dry colocasia leaves powder was found to be most accepted.

The mean score secured for taste were ranging from 4.6 to 4.9. The highest score (4.9) for taste was secured by 7 per cent level of dry colocasia powder incorporation while the minimum score was 4.6 which was allotted for 5, 6 and 7 per cent incorporation. The results showed that the taste for colocasia varan at 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia powder was significantly different.

Scores registered for the flavour of colocasia varan with 0, 4, 5, 6 and 7 per cent level of incorporation of dry colocasia leaves powder were between 4.5 to 4.8. The highest scores of 4.8 for flavor were corded by colocasia varan prepared with 7 per cent level of incorporation of colocasia powder. Statistically analysis showed that difference was significant. On the whole, it was inferred that 7 per cent level of incorporation of dry colocasia leaves powder in colocasia varan was considerd as most suitable level.

The mean scores for overall acceptability of colocasia varan with 0, 4, 5, 6 and 7 per cent level of incorporation colocasia leaves powder were 4.4, 4.5, 4.6, 4.8 and 4.8 respectively. Statistical analysis indicated that scores obtained by colocasia varan at various levels of incorporation of colocasia leaves powder differed significantly. The highest score (4.8) for the overall acceptability was secured by 7 per cent level of incorporation of dry colocasia leaves powder in colocasia varan. Hence, it is concluded that addition of dry colocasia leaves powder up to 7 per cent level in colocasia varan was well accepted by panel members.
Table 8. Organoleptic evaluation scores of colocasia varan

| Variations | Level of colocasia leaves incorporation (%) | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|------------------------------------------|--------|---------|-------|---------|-----------------------|
| Basic      | 0                                        | 4.6    | 4.8     | 4.7   | 4.8     | 4.4                   |
| I          | 4                                        | 4.2    | 4.6     | 4.6   | 4.6     | 4.5                   |
| II         | 5                                        | 4.4    | 4.6     | 4.6   | 4.6     | 4.6                   |
| III        | 6                                        | 4.8    | 4.8     | 4.6   | 4.5     | 4.8                   |
| IV         | 7                                        | 4.8    | 3.9     | 4.9   | 4.8     | 4.8                   |
| CD         | 0.3                                      | 0.2    | 0.1     | 0.2   | 0.2     | 0.2                   |
| SE±        | 0.1                                      | 0.1    | 0.04    | 0.08  | 0.09    |                       |
| F-value    | 3.8**                                    | 13.6** | 3.0*    | 3.1*  | 2.7*    |                       |

NS: Non significant  *Significant at 5 per cent       **Significant at 1 per cent

4.2. Nutrient analysis of value added developed product

4.2.1. Nutrient analysis of value added developed products with fresh colocasia leaves

4.2.1.1. Nutrients analysis of colocasia dhapata

Nutritional composition of colocasia dhapata developed without incorporation of colocasia leaves (basic) and with colocasia leaves (most accepted experimental variations) are presented in Table 9.

The moisture, protein, fat, total mineral, fibre, carbohydrate, calcium, iron, copper, zinc and manganese content of control and accepted colocasia dhapata were 20.61 ± 0.98g and 21.73 ± 1.04g, 9.6 ± 0.36g and 11.0 ± 1.0g, 6.55 ± 0.05g and 6.47 ± 0.02g, 1.32 ± 0.17g and 1.45 ± 0.3g, 2.12 ± 0.27g and 2.70 ± 0.1g, 78.99 ± 0.10g and 81.87 ± 3.92g, 107.5 ± 2.5mg and 128.6 ± 1.35mg, 3.98mg ± 0.005 and 3.87 ± 0.10mg, 1.28 ± 0.02 and 1.35± 0.04mg, 2.27 ± 0.02mg and 2.31 ± 0.001mg, 0.68 ± 0.005mg and 0.75 ± 0.03mg /100g respectively.

The statistical analysis of the above values indicated that increase in calcium and manganese content of colocasia dhapata was statistically significant.
Fig. 8. Organoleptic evaluation scores of colocasia varan
Plate 9. *Colocasia puri* prepared with incorporation of dry colocasia leaves powder.

Plate 10. *Colocasia varan* prepared with incorporation of dry colocasia leaves powder.
### Table 9. Nutrient content of Colocasia *dhapata* (per 100g)

| Nutrients               | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|-------------------------|-----------------|---------------------|-----------|
| Moisture (g)            | 20.61 ± 0.98    | 21.73 ± 1.04        | 1.10NS    |
| Protein (g)             | 9.6 ± 0.36      | 11.0 ± 1.0          | 1.86NS    |
| Fat (g)                 | 6.55 ± 0.05     | 6.47 ± 0.02         | 0.22NS    |
| Total minerals (g)      | 1.32 ± 0.17     | 1.45 ± 0.3           | 0.53NS    |
| Fibre (g)               | 2.12 ± 0.27     | 2.70 ± 0.1           | 2.84NS    |
| Carbohydrates (g)       | 78.99 ± 0.10    | 81.87 ± 3.92         | 1.03NS    |
| Calcium (mg)            | 107.5 ± 2.5     | 128.6 ± 1.35         | 10.52**   |
| Iron (mg)               | 3.98 ± 0.005    | 3.87 ± 0.1           | 1.55NS    |
| Copper (mg)             | 1.28 ± 0.02     | 1.35 ± 0.04          | 0.48NS    |
| Zinc (mg)               | 2.27 ± 0.02     | 2.31 ± 0.001         | 2.82NS    |
| Manganese (mg)          | 0.68 ± 0.005    | 0.75 ± 0.03          | 3.25*     |

NS: Non significant   *Significant at 5 per cent           **Significant at 1 per cent

There was no significant difference increase in other nutrient content but numerically increased was seen in moisture, protein, fat, total mineral, fibre, carbohydrate, copper and zinc.

#### 4.2.1.2. Nutrients analysis of colocasia *masala vada*

The nutritional composition of colocasia *masala vada* before and after incorporation of colocasia leaves are presented in Table 10. After analyzing the samples in laboratory the obtained composition of colocasia *masala vada* showed numerical increase in nutrient content over colocasia *masala vada* prepared without addition of colocasia leaves. The values of basic and accepted colocasia *masala vada* were moisture 33.15 ± 8.80g and 34.92 ± 8.59g, protein 26.26 ± 0.78g and 28.00 ± 1.00g, fat 17.70 ± 0.45g and 18.15 ± 0.00g, total minerals 2.87 ± 0.82g and 2.97 ± 0.07g, fibre 2.02 ± 0.02g and 2.42 ± 0.07g, carbohydrate 51.13 ± 0.39 and 45.25 ± 5.25g, calcium 113.5 ± 1.5mg and 135 ± 4.5mg, iron 6.32 ± 0.01 mg and 6.45 ± 0.17mg, copper 1.35 ± 0.005 mg and 1.44 ± 0.04mg, zinc 1.02 ± 0.005mg and 1.04 ± 0.005mg, manganese 1.07 ± 0.025mg and 1.14 ± 0.005mg /100g.
Table 10. Nutrient content of *clocasia masala vada* (per 100g)

| Nutrients           | Basic       | Accepted    | ‘t’ value |
|---------------------|-------------|-------------|-----------|
|                     | Mean ± SD   | Mean ± SD   |           |
| Moisture (g)        | 33.15 ± 8.80| 34.92 ± 8.59| 0.19 NS   |
| Protein (g)         | 26.26 ± 0.78| 28.00 ± 1.00| 1.94 NS   |
| Fat (g)             | 17.70 ± 0.45| 18.15 ± 0.00| 1.41 NS   |
| Total minerals (g)  | 2.87 ± 0.82 | 2.97 ± 0.07 | 0.17 NS   |
| Fibre (g)           | 2.02 ± 0.02 | 2.42 ± 0.07 | 4.27 *    |
| Carbohydrates (g)   | 51.13 ± 0.39| 45.25 ± 5.25| 1.57 NS   |
| Calcium (mg)        | 113.5 ± 1.5 | 135 ± 4.5   | 6.41 **   |
| Iron (mg)           | 6.32 ± 0.01 | 6.45 ± 0.17 | 1.07 NS   |
| Copper (mg)         | 1.35 ± 0.005| 1.44 ± 0.04 | 3.15 NS   |
| Zinc (mg)           | 1.02 ± 0.005| 1.04 ± 0.005| 4.0 *     |
| Manganese (mg)      | 1.07 ± 0.025| 1.14 ± 0.005| 4.80 *    |

NS: Non significant  * Significant at 5 per cent  ** Significant at 1 per cent

The values were significantly increased for fibre, calcium, zinc and manganese content. There was no significant increase in other nutrient content but numerically it was increased in moisture, protein, fat, total minerals, calcium, iron, copper and non-significantly decrease in carbohydrate content.

### 4.2.1.4. Nutrients analysis of coconut chutney with colocasia leaves

The nutritional composition of coconut chutney before and after incorporation of colocasia leaves are presented in Table 11 serve as basic and accepted.

After analyzing the samples in laboratory the obtained composition of coconut chutney with colocasia leaves numerical increase in nutrient content over coconut chutney prepared with colocasia without addition of colocasia leaves.
The value of basic and accepted coconut chutney with colocasia were moisture 69.31 ± 3.23g and 69.66 ± 1.34g, protein 3.78 ± 0.42g and 3.92 ± 0.28g, fat 17.7 ± 0.45g and 17.12 ± 2.77g, total minerals 5.9 ± 0.5g and 6.0 ± 1.5g, fibre 1.45 ± 0.45g and 1.65 ± 0.2g, carbohydrate 75.09 ± 4.09g and 71.30 ± 3.79g, calcium 48.75 ± 1.25mg and 68 ± 8.00mg, iron 1.34 ± 0.003mg and 1.52 ± 0.03mg, copper 1.30 ± 0.003mg and 1.42 ± 0.2mg, zinc 0.36 ± 0.006mg and 0.39 ± 0.0005mg, manganese 0.24 ± 0.005mg and 0.42 ± 0.02mg/100g.

The values were significantly increased for calcium, iron, copper, zinc and manganese content.

**Table. 11. Nutrient content of Coconut chutney with colocasia leaves**

(Per 100g)

| Nutrients          | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|--------------------|-----------------|--------------------|-----------|
| Moisture (g)       | 69.31 ± 3.23    | 69.66 ± 1.34       | 0.14NS    |
| Protein (g)        | 3.78 ± 0.42     | 3.92 ± 0.28        | 0.39NS    |
| Fat (g)            | 17.7 ± 0.45     | 17.12 ± 2.77       | 0.29NS    |
| Total minerals (g) | 5.9 ± 0.5       | 6.0 ± 1.5          | 0.08NS    |
| Fibre (g)          | 1.45 ± 0.45     | 1.65 ± 0.2         | 0.57NS    |
| Carbohydrates (g)  | 75.09 ± 4.09    | 71.30 ± 3.79       | 0.96NS    |
| Calcium (mg)       | 48.75 ± 1.25    | 68 ± 8.00          | 3.36*     |
| Iron (mg)          | 1.34 ± 0.003    | 1.52 ± 0.03        | 8.44**    |
| Copper (mg)        | 1.30 ± 0.003    | 1.42 ± 0.2         | 8.39**    |
| Zinc (mg)          | 0.36 ± 0.006    | 0.39 ± 0.0005      | 7.04**    |
| Manganese (mg)     | 0.24 ± 0.005    | 0.42 ± 0.02        | 12.34**   |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent

**4.2.1.3. Nutrients analysis of bengal gram chutney with colocasia leaves**

The data on nutritional composition of bengal gram chutney developed without incorporation of colocasia leaves (basic) and with colocasia leaves (most accepted experimental variations) are presented in Table.12.
The moisture, protein, fat, total mineral, fibre, carbohydrate, calcium, iron, copper, zinc and manganese content of basic and accepted bengal gram chutney with colocasia leaves were 72.46 ± 1.22g and 73.22 ± 2.99g, 5.32 ± 0.28g and 6.86 ± 0.14g, 6 ± 3.55g and 6.11± 0.1g, 2.05 ± 0.025g and 2.9 ± 1.75g, 0.67 ± 0.25g and 0.8 ± 0.30g, 85.10 ± 5.55g and 84.54 ± 0.41g, 67.5 ± 12.5mg and 82 ± 8.00mg, 6.37 ± 0.02mg and 6.42 ± 0.02mg, 0.67 ± 0.04mg and 0.87 ± 0.02mg, 0.38 ± 0.06mg and 0.45 ± 0.065mg, 0.24 ± 0.001mg and 0.28 ± 0.03mg/100g respectively.

The statistical analysis of the above values indicated that increase in protein and copper content of bengal gram chutney with colocasia leaves was statistically significant.

Akoja 2016 found same results in his study and there was increase in protein fat and fibre with addition of colocasia leaf shoot.

Result showed non-significant variation in moisture, fat, total minerals, fibre, carbohydrates, calcium iron, copper, zinc and manganese content between basic and experimental variation.

Table 12. Nutrient content of bengal gram chutney with colocasia leaves (per100g)

| Nutrients        | Basic          | Accepted       | ‘t’ value |
|------------------|----------------|----------------|-----------|
|                  | Mean ± SD      | Mean ± SD      |           |
| Moisture (g)     | 72.46 ± 1.22   | 73.22 ± 2.99   | 0.33NS    |
| Protein (g)      | 5.32 ± 0.28    | 6.86 ± 0.14    | 6.95**    |
| Fat (g)          | 6 ± 3.55       | 6.11 ± 0.1     | 0.04NS    |
| Total minerals (g)| 2.05 ± 0.025   | 2.9 ± 1.75     | 0.96NS    |
| fibre (g)        | 0.67 ± 0.25    | 0.8 ± 0.30     | 0.61NS    |
| Carbohydrates (g)| 85.10 ± 5.55   | 84.54 ± 0.41   | 0.14NS    |
| Calcium (mg)     | 67.5 ± 12.5    | 82 ± 8.00      | 1.38NS    |
| Iron (mg)        | 6.37 ± 0.02    | 6.42 ± 0.02    | 2.5NS     |
| Copper (mg)      | 0.67 ± 0.04    | 0.87 ± 0.02    | 6.32**    |
| Zinc (mg)        | 0.38 ± 0.06    | 0.45 ± 0.065   | 0.31NS    |
| Manganese (mg)   | 0.24 ± 0.001   | 0.28 ± 0.03    | 1.88NS    |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent
4.2.2. Nutrient analysis of value added developed products with dry colocasia leaves powder

4.2.2.1. Nutrients analysis of colocasia dhokla

The nutritional composition of colocasia dhokla before and after incorporation of colocasia leaves powder are illustrated in Table 13.

After analyzing the samples in laboratory the obtained composition of colocasia dhokla showed numerical increase in nutrient content over colocasia dhokla prepared with and without addition of dry colocasia leaves powder. The values of basic. and accepted colocasia dhokla were moisture 48.26 ± 9.02g and 57.22 ± 4.11g, protein 17.3 ± 0.5g and 17.22 ± 0.42g, fat 6.1 ± 0.3g and 6.7 ± 0.1g, total minerals 4.72 ± 2.67g and 4.85 ± 1.15g, fibre 2.02 ± 0.02g and 2.27 ± 0.02g, carbohydrates 69.85 ± 2.85g and 68.95 ± 1.69g, calcium 51.25 ± 3.75mg and 141 ± 1.2mg, iron 4.02 ± 0.03mg and 4.8 ± 0.02mg, copper 1.28 ± 0.005mg and 1.77 ± 0.1mg, zinc 1.3 ± 0.71mg and 1.46 ± 0.01mg, manganese 0.49 ± 0.002mg and 0.50 ± 0.004mg/100g.

It was inferred that colocasia dhokla with addition of colocasia leaves powder had fibre, calcium, iron and copper content increased which were statistically significant.

Melase et al, (2017), studied that colocasia leaf is rich in proteins and can be supplementary protein, carotene and trace minerals in chicken diets.

The result showed that the incorporation of colocasia leaves was helpful in increasing the nutrient content.
Table 13. Nutrient content of *colocasia dhokla* (per 100g)

| Nutrients         | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|-------------------|-----------------|--------------------|-----------|
| Moisture (g)      | 48.26 ± 9.02    | 57.22 ± 4.11       | 1.27NS    |
| Protein (g)       | 17.3 ± 0.5      | 17.22 ± 0.42       | 0.17NS    |
| Fat (g)           | 6.1 ± 0.3       | 6.7 ± 0.1          | 2.68NS    |
| Total minerals (g)| 4.72 ± 2.67     | 4.85 ± 1.15        | 0.06NS    |
| Fibre (g)         | 2.02 ± 0.02     | 2.27 ± 0.02        | 12.5**    |
| Carbohydrates (g) | 69.85 ± 2.85    | 68.95 ± 1.69       | 0.38NS    |
| Calcium (mg)      | 51.25 ± 3.75    | 141 ± 1.2          | 32.23**   |
| Iron (mg)         | 4.02 ± 0.03     | 4.8 ± 0.02         | 5.45*     |
| Copper (mg)       | 1.28 ± 0.005    | 1.77 ± 0.1         | 6.9**     |
| Zinc (mg)         | 1.3 ± 0.71      | 1.46 ± 0.01        | 0.31NS    |
| Manganese (mg)    | 0.49 ± 0.002    | 0.50 ± 0.004       | 3.16NS    |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent

4.2.2.2. Nutrients analysis of colocasia *kharapara*

The nutritional composition of *kharapara* before and after incorporation of dry colocasia leaves powder are shown in Table 14 serve as basic and accepted.

After analyzing the samples in laboratory the obtained composition of *kharapara* has shown numerical increase in nutrient content over *kharapara* prepared with and without addition of dry colocasia leaves powder. The nutritional composition of basic and accepted products showed that moisture content 11.94 ± 0.34g and 12.32 ± 0.54g, protein 7.74 ± 0.23g and 8.54 ± 0.99g, fat 12.75 ± 0.05g and 13.65 ± 1.5g, total minerals 7.65 ± 2.35g and 8.02 ± 0.17g, fibre 2.97 ± 0.5g, and 3.2 ± 1.05g, carbohydrates 68.39 ± 1.65g and 65.07 ± 0.08g, calcium 126 ± 9mg and 218 ± 8.5mg, iron 6.39 ± 0.37mg and 6.52 ± 0.01mg, copper 1.07 ± 1.07mg and 1.43 ± 1mg, zinc 0.41 ± 0.003mg and 0.45 ± 0.007mg, manganese 0.74 ± 0.1mg and 0.78 ± 0.23mg/100gm.

The statistical analysis of the above values indicated that increase in calcium and zinc content of *kharapara* with dry colocasia leaves powder was
statistically significant. There was no significant increase in other nutrient content but numerically it was increased such as moisture, protein, fat, total mineral, fiber, iron, copper and manganese content and non-significantly decreases in carbohydrate content.

Table 14. Nutrient content of *colocasia kharapara* (per 100g)

| Nutrients         | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|-------------------|-----------------|--------------------|-----------|
| Moisture (g)      | 11.94 ± 0.34    | 12.32 ± 0.54       | 0.84NS    |
| Protein (g)       | 7.74 ± 0.23     | 8.54 ± 0.99        | 1.11NS    |
| Fat (g)           | 12.75 ± 0.05    | 13.65 ± 1.5        | 0.84NS    |
| Total minerals (g)| 7.65 ± 2.35     | 8.02 ± 0.17        | 0.22NS    |
| fibre (g)         | 2.97 ± 0.5      | 3.2 ± 1.05         | 0.24NS    |
| Carbohydrates (g) | 68.39 ± 1.65    | 65.07 ± 0.08       | 2.40NS    |
| Calcium (mg)      | 126 ± 9         | 218 ± 8.5          | 10.51**   |
| Iron (mg)         | 6.39 ± 0.37     | 6.52 ± 0.01        | 0.49NS    |
| Copper (mg)       | 1.07 ± 1.07     | 1.43 ± 1           | 0.34NS    |
| Zinc (mg)         | 0.41 ± 0.003    | 0.45 ± 0.007       | 7.42**    |
| Manganese (mg)    | 0.74 ± 0.1      | 0.78 ± 0.23        | 0.24NS    |

NS: Non significant *Significant at 5 per cent **Significant at 1 per cent

4.2.2.3. Nutrients analysis of *colocasia puri*

Nutritional composition of *puri* developed without incorporation of dry colocasia leaves powder (basic) and with dry colocasia leaves powder (most accepted experimental variations) are presented in Table.15.

There was found to be numerical increase in moisture 19.9 ± 0.98g and 22.79 ±1.91g, protein 5.7 ± 0.1g and 6.02 ± 0.14g, fat 12.45 ± 0.05g and 13 ± 0.5g, total minerals 2.4 ± 1.75g and 2.47 ± 0.02g, fibre 0.75 ± 0.15g and 0.95 ± 0.2g, carbohydrate 78.7 ± 1.65g and 79.09 ± 2g and zinc 1.42 ± 0.03mg and 1.54 ± 0.05mg content of experimental products over the basic however, it could not reach to the level of significance.

Calcium, copper and manganese content of *puri* prepared with colocasia leaves powder shown significant increase in nutrient content over *puri* prepared without incorporation of dry colocasia leaves powder. The values were
significantly increased for calcium $157 \pm 20$mg, iron $4.38 \pm 0.002$mg and $4.43 \pm 0.02$mg, manganese $1.43 \pm 0.03$ mg/100gm.

Table 15. Nutrient content of *colocasia puri* (per 100g)

| Nutrients     | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|---------------|-----------------|--------------------|-----------|
| Moisture (g)  | 19.9 ± 0.98     | 22.79 ±1.91        | 2.33NS    |
| Protein (g)   | 5.7 ± 0.1       | 6.02 ± 0.14        | 3.22NS    |
| Fat (g)       | 12.45 ± 0.5     | 13 ± 0.5           | 1.54NS    |
| Total minerals (g) | 2.4 ± 1.75 | 2.47 ± 0.02        | 0.05NS    |
| fibre (g)     | 0.75 ± 0.15     | 0.95 ± 0.2         | 1.13NS    |
| Carbohydrates (g) | 78.7 ± 1.65 | 79.09 ± 2          | 0.21NS    |
| Calcium (mg)  | 65 ± 5          | 157 ± 20           | 6.31**    |
| Iron (mg)     | 4.38 ± 0.002    | 4.43 ± 0.02        | 3.51*     |
| Copper (mg)   | 0.88 ± 0.02     | 0.75 ± 0.05        | 3.41*     |
| Zinc (mg)     | 1.42 ± 0.03     | 1.54 ± 0.05        | 2.91NS    |
| Manganese (mg)| 1.30 ± 0.005    | 1.43 ± 0.03        | 6.08**    |

NS: Non significant  *Significant at 5 per cent   **Significant at 1 per cent

4.2.2.4. Nutrients analysis of colocasia *varan*

The nutritional composition of *varan* before and after incorporation of dry colocasia leaves powder are illustrated in Table 16. After analyzing the samples in laboratory the obtained composition of colocasia *varan* showed numerical increase in nutrient content over *varan* prepared with and without addition of colocasia leaves powder. The values of basic and accepted colocasia *varan* were moisture $67.56 \pm 1.12$g and $69.92 \pm 1.48$g, protein $25.06 \pm 0.42$g and $24.92 \pm 0.28$g, fat $3.95 \pm 0.05$g and $4.2 \pm 0.1$g, total minerals $2.62 \pm 1.12$g and $2.83 \pm 1.72$g, fibre $2.3 \pm 0.4$g and $2.7 \pm 1.22$g, carbohydrates $65.90 \pm 1.21$g and $65.35 \pm 0.14$g, copper $1.29 \pm 0.01$mg and $1.43 \pm 0.5$mg/100gm.

It is reported that, values were significantly increased for calcium $169.5 \pm 4.5$mg, iron $2.54 \pm 0.05$mg, zinc $0.49 \pm 0.004$mg and manganese $0.64 \pm 0.04$mg/100gm. It was inferred that colocasia *varan* with addition of colocasia
leaves powder had calcium, iron, zinc and manganese content increased which were statistically significant.

Anju et al, (2017) also found that increase in calcium in gatte ki subji and mathari with the incorporation of dried colocasia leaves powder as compared to standard recipe.

The results showed that the incorporation of dry colocasia leaves powder was helpful in increasing the nutrient content.

**Table 16. Nutrient content of *colocasia varan* (per 100g)**

| Nutrients          | Basic Mean ± SD | Accepted Mean ± SD | ‘t’ value |
|--------------------|-----------------|--------------------|-----------|
| Moisture (g)       | 67.56 ± 1.12    | 69.92 ± 1.48       | 1.76NS    |
| Protein (g)        | 25.06 ± 0.42    | 24.92 ± 0.28       | 0.39NS    |
| Fat (g)            | 3.95 ± 0.05     | 4.2 ± 0.1          | 3.16NS    |
| Total minerals (g) | 2.62 ± 1.12     | 2.83 ± 1.72        | 0.14NS    |
| fibre (g)          | 2.3 ± 0.4       | 2.7 ± 1.22         | 0.44NS    |
| Carbohydrates (g)  | 65.90 ± 1.21    | 65.35 ± 0.14       | 0.63NS    |
| Calcium (mg)       | 70.5 ± 3.5      | 169.5 ± 4.5        | 24.55**   |
| Iron (mg)          | 2.23 ± 0.1      | 2.54 ± 0.05        | 3.92*     |
| Copper (mg)        | 1.29 ± 0.01     | 1.43 ± 0.5         | 0.39NS    |
| Zinc (mg)          | 0.45 ± 0.01     | 0.49 ± 0.004       | 5.25*     |
| Manganese (mg)     | 0.21 ± 0.1      | 0.64 ± 0.04        | 5.64*     |

NS: Non significant  *Significant at 5 per cent  **Significant at 1 per cent

### 4.3. Shelf life of value added developed products

#### 4.3.1. Shelf life of colocasia dhapata

The mean scores for overall acceptability of colocasia *dhapata* stored in zip lock bag and aluminium foil for varying period is given in Table 17 and illustrated in Fig. 10.

Results indicated that scores recorded for *dhapata* at initial stage in both storage pack were 4.66 ± 0.48. Minimum score recorded for *dhapata* stored for 4 days was 3.06 ± 0.45 for colocasia *dhapata* stored in zip lock bag.
It was found that as the period of storage increased, overall acceptability was found to be decreased in both samples. Though there was decrease in the sensory scores the samples were well accepted and acquired scores of good category (3.06 ± 0.45 and 3.33 ± 0.48) in both zip lock bag and aluminium foil after 4 days of storage respectively.

However, at 4 days there was non-significant reduction in the acceptability scores of dhapata stored in both packaging material. From the data it is apparent that colocasia dhapata can be stored at room temperature in an acceptable state up to 4 days in zip lock bag and aluminium foil.

Table 17. Mean scores for overall acceptability of colocasia dhapata stored in zip lock bag and aluminium foil for varying periods.

| Storage period (Days) | Mean scores for overall acceptability for colocasia dhapata | ‘t’ value |
|-----------------------|----------------------------------------------------------|----------|
|                       | Zip lock bag Mean ± SD | Aluminium foil Mean ± SD |        |
| 1                     | 4.66 ± 0.48           | 4.66 ± 0.48               | 0.00 NS |
| 2                     | 4.13 ± 0.35           | 4.46 ± 0.51               | 2.64 NS |
| 3                     | 3.66 ± 0.48           | 3.73 ± 0.70               | 0.36 NS |
| 4                     | 3.06 ± 0.45           | 3.33 ± 0.48               | 1.46 NS |
| CD                    | 0.330                  | 0.408                     |        |
| SE ±                  | 0.116                  | 0.144                     |        |
| F- value              | 34.3**                 | 18.86**                   |        |

NS: Non significant

4.3.2. Shelf life of colocasia masala vada

Mean scores for overall acceptability of masala vada prepared with incorporation of colocasia leaves stored in zip lock bag and aluminium foil for varying periods is given in Table 18 and illustrated in Fig 11.

The mean scores for overall acceptability of colocasia masala vada stored in zip lock bag for varying periods were 5.00 ± 0.00, 4.73 ± 0.45 and 3.26 ± 0.45. Whereas corresponding scores were 5.00 ± 0.00, 4.86 ± 0.35 and 3.73 ± 0.70 for the colocasia masala vada stored in aluminium foil.
Fig. 9. Mean score for overall acceptability of colocasia *dhapata* stored in zip lock bag and aluminum foil for varying periods.
Overall acceptability score of colocasia *masala vada* stored for 3 days in zip lock bag and aluminium foil did not differed significantly. It was observed that almost same scores were secured by colocasia *masala vada* in both pouches for 3 days.

The initial scores of $5.00 \pm 0.00$ was non-significantly reduced to $3.26 \pm 0.45$ and $3.73 \pm 0.70$ respectively for the samples from zip lock bag and aluminum foil over 3 days period of storage.

Hence, it can be concluded from the findings that the effect of storage period was non-significantly noticed on overall acceptability of colocasia *masala vada* stored in zip lock bags and aluminium foil pouches. Overall acceptability score decreased in both the samples as the period of storage was increased.

**Table 18. Mean scores for overall acceptability of colocasia *masala vada* stored in zip lock bag and aluminium foil for varying periods.**

| Storage period (Days) | Mean scores for overall acceptability for colocasia *masala vada* | ‘t’ value |
|-----------------------|---------------------------------------------------------------|-----------|
|                       | Zip lock bag Mean ± SD | Aluminium foil Mean ± SD |             |
| 1                     | 5.00 ± 0.00            | 5.00 ± 0.00              | 0.000 **NS** |
| 2                     | 4.73 ± 0.45            | 4.86 ± 0.35              | 1.000 **NS** |
| 3                     | 3.26 ± 0.45            | 3.73 ± 0.70              | 1.704 **NS** |
| CD                    | 0.276                  | 0.336                    |             |
| SE ±                  | 0.096                  | 0.117                    |             |
| F- value              | 93.54**                | 32.21**                  |             |

NS: Non significant

**4.3.3. Shelf life of colocasia dhokla**

Mean sensory scores recorded in table 19 and Fig 19 showed the colocasia *dhokla* stored in two different pouches. There was considerable change in the sensory scores of the colocasia *dhokla* stored in the pouches during 3 days storage.
Fig. 10. Mean score for overall acceptability of colocasia masala vada stored in zip lock bag and aluminum foil for varying periods.
The overall mean scores were reduced significantly from second day for the sample stored in both the pouches. Initially the acceptability score was 4.86 ± 0.35 which was reduced to 3.26 ± 0.59 and 3.40± 0.73 for zip lock bag and aluminium foil storage pouch respectively.

Statistical analysis of data revealed significant reduction in the overall acceptability scores. There was no difference between the scores allotted for colocasia dhokla stored in both pouches. Up to 1 day of storage the scores were same for colocasia dhokla from both pouches. The overall acceptability score decreased in both the samples as the period of storage increased.

**Table 19. Mean scores for overall acceptability of colocasia dhokla stored in zip lock bag and aluminium foil for varying periods.**

| Storage period (Days) | Mean scores for overall acceptability for colocasia dhokla | ‘t’ value |
|-----------------------|----------------------------------------------------------|-----------|
|                       | Zip lock bag Mean ± SD | Aluminium foil Mean ± SD |          |
| 1                     | 4.86 ± 0.35            | 4.86 ± 0.35            | 0.000NS  |
| 2                     | 4.40 ± 0.73            | 4.66 ± 0.48            | 1.074NS  |
| 3                     | 3.26 ± 0.59            | 3.40 ± 0.73            | 0.619NS  |
| CD                    | 0.431                   | 0.406                  |          |
| SE ±                  | 0.150                   | 0.142                  |          |
| F- value              | 29.897**               | 31.463**               |          |

NS: Non significant

**4.3.4. Shelf life of colocasia kharapara**

Mean scores for overall acceptability of kharapara with incorporation of colocasia powder stored in zip lock bag and aluminium foil for varying periods is given in Table 20 and illustrated in Fig 20.

The mean scores for overall acceptability of colocasia kharapara stored in zip lock bag for varying periods were 4.93± 0.25, 4.73± 0.45, 3.73± 0.59, 3.40± 0.50 and 2.93± 0.45. Whereas corresponding scores were 4.93± 0.25, 4.80± 0.41, 4.13± 0.51, 3.53± 0.51 and 3.46±0.74 for the colocasia kharapara stored in aluminium foil.
Fig. 11. Mean score for overall acceptability of *colocasia dhokla* stored in zip lock bag and aluminum foil for varying periods.
Overall acceptability score of colocasia *kharapara* stored for 28 days in zip lock bag and aluminum foil did not differed significantly. It was observed that almost same score was secured by colocasia *kharapara* in both pouches for 28 days.

The initial score of 4.93± 0.25was significantly reduced to 2.93± 0.45 and 3.46±0.74 respectively for the samples from zip lock bag and aluminium foil over 28 days period of storage.

Hence, it can be concluded from the findings that the effect of storage period was non-significantly noticed on overall acceptability of colocasia *kharapara* stored in zip lock bags and aluminium foil pouch. Also overall acceptability score was decreased in both the samples as the period of storage was increased.

**Table 20. Mean scores for overall acceptability of colocasia *kharapara* stored in zip lock bag and aluminium foil for varying periods.**

| Storage period (Days) | Mean scores for overall acceptability for colocasia *kharapara* | ‘t’ value |
|-----------------------|---------------------------------------------------------------|-----------|
|                       | Zip lock bag | Aluminium foil | | |
|                       | Mean ± SD    | Mean ± SD      | | |
| 1                     | 4.93 ± 0.25  | 4.93 ± 0.25    | 0.000 NS |
| 7                     | 4.73 ± 0.45  | 4.80 ± 0.41    | 1.146 NS |
| 14                    | 3.73 ± 0.59  | 4.13 ± 0.51    | 0.323 NS |
| 21                    | 3.40 ± 0.50  | 3.53 ± 0.51    | 1.784 NS |
| 28                    | 2.93 ± 0.45  | 3.46 ± 0.74    | 1.169 NS |
| CD                    | 0.342        | 0.376          |           |
| SE ±                  | 0.121        | 0.133          |           |
| F- value              | 50.73**      | 26.64**        |           |

NS: Non significant

**4.3.4. Shelf life of colocasia *puri***

The mean scores for overall acceptability of developed colocasia *puri* stored in zip lock bag and aluminium pouch for varying periods is given in Table 21 and shown in Fig. 21.

Wide variations were noticed in acceptability scores registered by colocasia *puri* stored in zip lock bag (4.93± 0.25 and 3.46± 0.74) and...
Fig. 12. Mean score for overall acceptability of *colocasia kharapara* stored in zip lock bag and aluminum foil for varying periods.
aluminium foil (4.93± 0.25 and 3.73 ± 0.59) over a period of 5 days. It was noticed that the score of colocasia *puri* up to one day was same for sample stored in zip lock bag was less than the one stored in aluminum foil. Result indicated that as the period of storage was increased the acceptability of colocasia *puri* stored in both packages was found to be decreased.

The acceptability scores were good up to entire period of storage for the colocasia *puri* stored in both the pouched though there was subsequent reduction in the scores along with increasing period. Hence, it can be concluded that colocasia *puri* can be stored for 5 days period in acceptable condition at room temperature.

From the above discussion it can be concluded that colocasia leaves are rich in calcium iron as well as micronutrients. Calcium required as development, growth and maintenance of bones, regulate muscle contraction, including beating of heart muscles and also required for blood clotting. Iron help in red blood cell formation. Micronutrients play a central role in metabolism and in maintenance of tissue function. So the incorporation of colocasia leaves in the diet will supply all these nutrients and maintain good health.

**Table 21. Mean score for overall acceptability of colocasia *puri* stored in zip lock bag and aluminium foil for varying periods.**

| Storage period (Days) | Mean score for overall acceptability for colocasia *puri* | ‘t’ value |
|-----------------------|---------------------------------------------------------|-----------|
|                       | Zip lock bag Mean ± SD | Aluminium foil Mean ± SD |           |
| 1                     | 4.93 ± 0.25            | 4.93 ± 0.25            | 0.000 **NS** |
| 2                     | 4.60 ± 0.41            | 4.80 ± 0.41            | 1.146 **NS** |
| 3                     | 4.33 ± 0.51            | 4.40 ± 0.50            | 0.323 **NS** |
| 4                     | 3.60 ± 0.51            | 3.93 ± 0.45            | 1.784 **NS** |
| 5                     | 3.467 ± 0.74           | 3.73 ± 0.59            | 1.169 **NS** |
| CD                    | 0.362                   | 0.336                   |           |
| SE ±                  | 0.128                   | 0.119                   |           |
| F- value              | 24.60**                 | 19.48**                 |           |

NS: Non significant
Fig. 13. Mean score for overall acceptability of *colocasia puri* stored in zip lock bag and aluminum foil for varying periods.
CHAPTER 5

SUMMARY AND CONCLUSION

An investigation entitled ‘Development of value added food products with incorporation of colocasia leaves’ was undertaken to develop various recipes with value addition. The methods used and the results emerged out of the experiment were presented and discussed in previous chapters and summarized below. Value added products were prepared with fresh colocasia leaves and dry colocasia leaves powder. For the preparation of products with fresh colocasia leaves, the colocasia leaves were boiled and then added in the products with different variation. The products prepared with the fresh colocasia leaves were colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves and bengal gram chutney with colocasia leaves. The products prepared with incorporation of dry colocasia leaves powder at varying level were colocasia dhokla, colocasia kharapara, colocasia puri and colocasia varan. Prepared products were evaluated for sensory characteristics and highly accepted products were analyzed for nutrient content.

Colocasia dhapata prepared with various levels (0, 7, 8, 9, and 10 per cent) of incorporation and without incorporation of fresh colocasia leaves, when subjected to organoleptic evaluation indicated that 10 per cent incorporation of colocasia leaves was well accepted (except texture) by panel members. The maximum score (4.8) for the overall acceptability was secured by 10 per cent level of incorporation of colocasia leaves in colocasia dhapata while the minimum score was 4.5 at 7 per cent level of incorporation of fresh colocasia leaves.

Organoleptic evaluation of colocasia masala vada with 0, 7, 8, 9 and 10 per cent level of incorporation of fresh colocasia leaves and without addition of colocasia leaves indicated that colocasia masala vada with 10 per cent of fresh colocasia leaves obtained highest scores. The highest scores of 4.8 for overall acceptability was recorded by colocasia masala wada prepared with 9 and 10 per cent level of incorporation of fresh colocasia leaves.
Coconut chutney with colocasia leaves was prepared by incorporating colocasia leaves at various levels ranging from 7 to 10. The mean scores registered for overall acceptability of coconut chutney with fresh colocasia leaves were ranging from 3.4 to 4.6 the minimum score (3.4) was obtained by 8 per cent incorporation of fresh colocasia leaves and the highest (4.6) was recorded by 10 per cent incorporation fresh colocasia leaves in coconut chutney recorded highest score in colour, texture, taste, flavour and over all acceptability. After sensory evaluation it was noticed that 10 per cent of colocasia leaves incorporation was the most accepted variation by judges for coconut chutney.

The mean scores secured for overall acceptability of bengal gram chutney with colocasia leaves were ranging from 3.1 to 4.3. The highest score (4.3) for overall acceptability was secured by 10 per cent level of colocasia leaves incorporation while the minimum score was 3.1. Organoleptic evaluation of bengal gram chutney before and after addition of colocasia leaves indicated that bengalgram chutney with 10 per cent of colocasia leaves obtained maximum values.

It is concluded from the finding that 10 per cent colocasia leaves can be incorporated in colocasia dhapata, colocasia masala vada, coconut chutney with colocasia leaves, bengalgram chutney with colocasia leaves.

Colocasia leaves was incorporated in dhokla from 4 to 7 per cent level. The results revealed that colocasia leaves powder incorporation up to 6 per cent in dhokla was best accepted by panel members.

Sensory evaluation of kharapara was well accepted up to 7 per cent level of colocasia leaves powder incorporation. Organoleptic evaluation of products developed with incorporation of colocasia leaves powder indicated that colocasia leaves powder can be successfully incorporated up to 7 per cent in various products. On the whole, it can be said that addition of dry colocasia leaves powder up to 7 per cent in kharapara did not affect sensory qualities except texture of colocasia kharapara.
Puri prepared with various levels (up to 7 per cent) of incorporation and without incorporation of colocasia leaves powder, when subjected to organoleptic evaluation indicated that 6 per cent incorporation of colocasia leaves was well accepted by panel members.

Dry colocasia leaves powder was incorporated in varan from 4, 5, 6 and 7 per cent level. The maximum score (4.8) for the overall acceptability was secured by 7 per cent level of incorporation of dry colocasia leaves powder in colocasia varan. The results revealed that colocasia leaves powder incorporation up to 7 per cent in varan was best accepted by panel members.

It is concluded from the findings that incorporation of 7 per cent dry colocasia leaves powder in colocasia kharapara and colocasia varan was best accepted by panel members. Whereas, 6 per cent colocasia leaves powder incorporation in colocasia dhokla and colocasia puri was best accepted for value addition of products.

The nutrient analysis of developed recipes showed that addition fresh colocasia leaves and dry colocasia leaves powder could increase the nutrient content of the developed products.

Incorporation of colocasaia leaves in dhapata, increased in calcium content (128.6 ± 1.35mg) and magnesium (0.75 ± 0.03mg/100gm) significantly. There was no significant difference increase in other nutrient content but numerically increased was seen in moisture, protein, fat, total mineral, fibre, carbohydrate, copper and zinc.

Masala vada with addition of colocasia leaves showed significant increase in values of nutrients such as fibre 2.42 ± 0.07g calcium 135 ± 4.5mg, zinc 1.04 ± 0.005mg, manganese 1.14 ± 0.005mg 100g. Other nutrients were numerically increased.

In the coconut chutney numerical increase was seen in moisture (69.66 ± 1.34g), protein (3.92 ± 0.28g), fat (17.12 ± 2.77g), total mineral (6.0 ± 1.5g) and fibre (1.65 ± 0.2g/100gm). Calcium, copper, iron, zinc and manganese
content increased significantly. Carbohydrate content was non-significantly decreased with incorporation of colocasia leaves.

Addition of colocasia leaves with bengal gram chutney resulted in increase of nutrient content significantly in case of protein 6.86 ± 0.14g and copper 0.87 ± 0.02mg/100gm. Moisture, fat, total mineral, fibre, carbohydrate, calcium, iron, zinc and manganese content decreased.

*Dhokla* with addition of colocasia leaves powder increased in fibre, calcium, iron and copper content. Another nutrient increase non significantly such as moisture, protein, fat, total mineral, zinc and manganese content.

Colocasia leaves powder was incorporated in *kharapara* up to 7 per cent level. The results revealed that colocasia leaves powder incorporation up to 7 per cent in *kharapara* was increased in nutrient content significantly in calcium, and copper content.

*Puri* with addition of colocasia leaves powder showed that significant increase in values of nutrients such as calcium, iron and manganese. Other nutrients were numerically increased.

Increase in calcium, copper, iron, zinc and manganese content significant in *colocasia varan*. Carbohydrate content was non significantly decreased with incorporation of colocasia leaves.

The storage study was carried out for five products colocasia *dhapata*, *colocasia masala vada*, *colocasia dhokla*, *colocasia kharapara* and *colocasia puri*. These products were kept in zip lock bag and aluminium foil for varying periods. They were evaluated for sensory qualities.

Colocasia *dhapata* was stored in zip lock bag and aluminium foil for 4 days. The sensory evaluation for overall acceptability was carried out daily. Results indicated that the scores recorded for the *dhapata* at initial stage in both storage pack were 4.66 ± 0.48. The sensory scores for overall acceptability decreased from second day. More decrease was seen in the product kept in zip lock bag. Though there was decrease in the sensory scores for overall
acceptability the samples were well accepted and acquired good category scores up to 4 days of storage in both the pouches.

Colocasia *masala vada* was stored in zip lock bag and aluminium foil for 3 days. The effect of storage period was non significantly noticed on overall acceptability of colocasia *masala vada* stored in zip lock bag and aluminium foil pouches, but overall acceptability score was decreasing in both the samples as the period of storage was increasing.

Colocasia *dhokla* was stored in zip lock bag and aluminum foil for 3 days. The initial score of overall acceptability were same for zip lock bag and aluminum foil. From second day mean scores of overall acceptability were decreasing but that were non significant.

Colocasia *kharapara* stored in zip lock bag and aluminum foil for 28 days. Overall acceptability scores of colocasia kharapara stored for 28 days in zip lock bag and aluminium foil did not differ significant. Kharapara is a deep fried product so can be kept for more days but some rancid flavor may develop with storage.

Colocasia puri was stored for five days in zip lock bag and aluminum foil. It was noticed that scores of colocasia puri for overall acceptability was good up to 3 days there after the scores decreased. The *colocasia puri* may be kept in aluminium foil up to five days.

It is concluded from this study that fresh colocasia leaves can be incorporated up to 10 per cent and dry colocasia leaves powder up to 6 to 7 per cent for value addition of different products. Colocasia leaves are rich in calcium so the calcium content of the products will be increased and will be useful to combat calcium deficiency. Colocasia leaves are also rich in minerals like iron, copper, zinc and manganese, so the addition of colocasia leaves will be helpful to cure micronutrient deficiencies.
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**APPENDIX I**

**Preparation of Basic Recipes**

**Dhapata**

| Ingredients       | Amount (g) |
|-------------------|------------|
| Jawar flour       | 60         |
| Bengal gram flour | 12         |
| Gingelly seeds    | 06         |
| Groundnut         | 07         |
| Turmeric          | 0.5        |
| Tamarind          | 0.5        |
| Red chillies      | 0.5        |
| Oil               | 2          |
| Rice flakes       | 12         |
| Salt              | A pinch    |
| Water             | As required|

**Procedure:**

1. Roast groundnuts, gingelly seeds and rice flakes, make a powder.
2. Mix jawar flour, bengal gram flour, groundnut powder, gingelly seed powder, rice flakes powder, turmeric, red chillies powder, tamarind pulp and salt. Make a dough.
3. Divide the dough into small balls and flattens with rolling pin and board.
4. Shallow fry them by applying oil.
Masala vada

Ingredients                           Amount (g)
Soya dal                                        45
Green gram dal                             35
Green chilles     2
Onion                                             2
Oil                                                  15
Salt                                               1

Procedure

1. Soak soya dal and green gram dal for 6 to 8 hrs., Grind soya dal and green gram dal to make a paste.

2. Add chopped green chillies, onion, salt and mix well.

3. Make into small balls and flatten with hand.

4. Deepfry in a pan till it get brown colour.
Coconut Chutney

| Ingredients         | Amount (g) |
|---------------------|------------|
| Fresh coconut       | 40         |
| Curd                | 56         |
| Green chillies      | 2          |
| Salt                | a pinch    |
| Garlic              | 2          |

**Procedure**

1. Grind fresh coconut well in the mixer to make a paste.

3. Add garlic, green chillies, salt and mix it with curd and serve.
Bengalgram chutney

| Ingredients        | Amount (g) |
|--------------------|------------|
| Bengal gram dal    | 40         |
| Curd               | 56         |
| Green chillies     | 2          |
| Salt               | a pinch    |
| Garlic             | 2          |

**Procedure**

1. Soak bengalgram dal for 5 to 6 hrs. then grind into paste.

2. Add garlic, green chillies and salt mix well with curd and serve.
Dhokla

| Ingredients       | Amount (gm) |
|-------------------|-------------|
| Bengal gram flour | 90          |
| Sugar             | 2.5         |
| Salt              | a pinch     |
| Citric Acid       | 2           |
| Backing soda      | 2           |
| Oil               | 1           |
| Cumin seed        | 0.5         |
| Mustard seeds     | 0.5         |
| Coriander leaves  | 1.5         |

Procedure:

1. Make a batter of Bengal gram flour, sugar, salt, citric acid by adding sufficient water to make pouring consistency. Add baking powder.
2. Greased the pan with oil and pour the batter in a pan, steam it in pressure cooker.
3. After cooling cut in to small pieces, add seasonings of mustard seeds, curry leaves and green chillies to it.
Kharapara

| Ingredient          | Amount (gm) |
|---------------------|-------------|
| Wheat flour         | 47          |
| Bengal gram flour   | 30          |
| Omum                | 5           |
| Cumin seed          | 5           |
| Red chillies        | 1           |
| Salt                | a pinch     |
| Coriander leaves    | 2           |
| Oil                 | 10          |

**Procedure**

1. Prepare dough of wheat flour.

2. Powder cumin seeds, omum, red chillies, salt and coriander leaves add to bengal gram flour mix and prepare dough.

3. Divide the dough of wheat flour stuff with bengalgram dough, make into small balls and flattens them with rolling pin and board, cut in diagonal shape.

4. Shallow fry those in pan till get brown colour.
Puri

**Ingredients**

| Ingredient      | Amount (g) |
|-----------------|------------|
| Wheat flour     | 82         |
| Cumin seed      | 2          |
| Green chillies  | 1          |
| Salt            | 1          |
| Coriander       | 2          |
| Oil             | 12         |

**Procedure**

1. Mix wheat flour with powder cumin seed, green chillies and coriander leaves.

2. Divide dough into small balls and flattens with rolling pin and board.

3. Fry in a pan till it get brown colour.
**Varan**

| Ingredients            | Amount (g) |
|------------------------|------------|
| Red gram dal           | 93         |
| Oil                    | 2          |
| Coriander leaves       | 2          |
| Cumin seed             | 1          |
| Mustard seed           |            |
| Onion                  | 2          |

**Procedure**

1. Cook dhal in pressure cooker, mash it season with cumin seed, mustard seed, coriander leaves and onion. Boil for another few minutes and serve.
APPENDIX II

Five Point Ranking Scale

Sensory Analysis

Name of product: ______________________ Date: ______________________

Name of panel member: ______________________

| Variations | Colour | Texture | Taste | Flavour | Overall acceptability |
|------------|--------|---------|-------|---------|-----------------------|
| I          |        |         |       |         |                       |
| II         |        |         |       |         |                       |
| III        |        |         |       |         |                       |
| IV         |        |         |       |         |                       |
| V          |        |         |       |         |                       |

5- Excellent
4- Very good
3- Good
2- Fair
1- Poor

Signature

Amerine M.A., Pongborn R.M. and Roessler E.D. (1965). Principles of sensory evaluation of foods. Academic Press, New York.
APPENDIX III

1. Determination of moisture content

Moisture content of the products was determined by oven drying method of (A.O.A.C., 1984).

Procedure

Three samples from each developed product were accurately weighed in an amount of 5.0g each in weighing bottle (previously heated to 90°C to 100°C and cooled in a desicator). The bottles were loosely covered with lids and heated in dry air oven for 3 hours at 105°C. after 3 hours bottles were removed from oven, allowed to cool in desicator and weighed accurately. Then again bottles were heated in oven for 1 hour and weighed accurately. Then again bottles were heated in oven for 1 hour and weighed. This procedure was repeated until the constant weight was observed. Moisture content of sample was calculated by the formula

\[
\text{Moisture content of the sample (\%) = } \frac{W_1 - W_2}{W} \times 100
\]

Where,

\( W_1 \) = Initial weight of bottle with sample before drying.

\( W_2 \) = Final weight of bottle with sample after drying

\( W \) = Weight of sample

2. Determination of total protein content of selected samples

Total protein content of the samples was estimated by determining total nitrogen content using standard macro-kjeldhal method (A.O.A.C., 1984).

. Total protein content was calculated by multiplying the estimated total nitrogen content with a factor 6.25.
2.1 Preparation of reagents

Catalyst mixture

It was prepared by grinding together 98 parts of potassium sulphate (K$_2$SO$_4$) and 2 parts of copper sulphate (CuSO$_4$).

40 per cent sodium hydroxide solution

An amount of 40 g sodium hydroxide pellets were dissolved in distilled water and diluted up to 100 ml.

Methyl red indicator

2 per cent boric acid solution

A weighed amount of 2 gm of boric acid was dissolved in distilled water and the volume was made up to 100 ml.

0.1 N Sulphuric acid

A measured quantity of 27.8 ml of concentrated sulphuric acid was dissolved in distilled water and the volume was made up to 100 ml. This solution gives 1 N sulphuric acid. Then 100 ml of 1 N sulphuric acid solution was diluted up to 1000 ml with distilled water.

Procedure

One gram of defatted powdered sample of each developed product was weighed on a butter paper, in triplicate and placed in 500 ml kjeldhal flask. An amount of 5.0 g of catalyst mixture, 20 ml of concentrate sulphuric acid and 2-3 glass bids were added into each flask. Similarly blank was also prepared using other reagents except sample. The contents in the flask were digested by heating for about 8 hours until the digested material was clear. The contents were allowed to cool and diluted by rinsing down the neck of the flask with distilled water. The contents were then transferred to a 100 ml. volumetric flask and the volume was made up to mark with distilled water. 10 ml of boric acid
solution was delivered in to a 100 ml conical flask and two drops of methyl red indicator were added and mixed well. The flask was then placed under the condenser with the tip of condenser extending below the surface of boric acid solution; 5 ml of digested sample was delivered into the distillation apparatus. Then 10 ml of 40 per cent NaOH was added and the funnel was washed with 2 to 3 ml of distilled water. Steam distillation was carried out and it was continued for 15 min, until about 40 ml of distillate was collected in boric acid solution. The tip of condenser was washed with distilled water and the flask was removed.

The ammonia collected in boric acid was titrated against the standard 0.1 N sulphuric acid solution. The end point of the titration was noted when 0.1 N sulphuric acid produced a light pink colour. Then the volume of 0.1 N sulphuric acid required to neutralize the collected sample was noted.

Total protein content of sample was calculated by formula.

\[
\text{Protein} \% = \frac{\text{Nitrogen} \% \times 6.25}{(\text{Titrate value of sample}) - (\text{Titrate value of blank}) \times \text{normality of sulphuric acid} \times 14 \times 100 \times \text{dilution factor}}
\]

Where,

\[
\text{Nitrogen} \% = \frac{(\text{Titrate value of sample}) - (\text{Titrate value of blank}) \times \text{normality of sulphuric acid} \times 14 \times 100 \times \text{dilution factor}}{\text{Wt. of sample (mg)}}
\]

3. Determination of total fat content

The fat content of selected sample was estimated by the Soxhlet method of A.O.A.C. (1984).

**Procedure**

Three Soxhlet flasks of 250 ml capacity were cleaned and dried in an oven to a constant weight. Then three samples in an amount of 5.0 g were accurately weighed on a butter paper from each selected product. Each weighed
sample was placed in thimbles and plugged with fat free cotton. Then the thimbles with the weighed sample were placed in the syphon portion of soxhlet apparatus. The volume of 160 ml of analytical grade petroleum ether and diethyl ether mixture (1:1) was placed in each round bottom flask of the soxhlet apparatus and it was connected to the soxhlet syphon and condenser. The condenser was plugged with moistened cotton. It was refluxed for 5-7 times at 60°C. Then ether was distilled off and flasks were placed on hot plate for 3 hours at 105°C for drying, cooled in a dedicator and weighed. Fat content of sample was calculated by using the formula.

\[
\text{Fat content (\%)} = \frac{W_2 - W_1}{X} \times 100
\]

Where,

- \( W_2 \) = Weight of round bottom flask with fat
- \( W_1 \) = Weight of empty round bottom flask
- \( X \) = Weight of sample

4. Estimation of total minerals

The total minerals of selected samples were estimated by the ashing method of A.O.A.C. (1984).

Procedure

Exactly 2.0 g sample was taken in three silica crucibles which were heated previously at 100°C and cooled. The crucibles were placed on a clay pipe triangle and were heated on a low flame till the samples were completely charred. The charred samples were ignited by placing crucibles in muffle furnace for 5 hours at 600°C. Thereafter crucibles were allowed to cool in desiccator and weighed. This procedure was repeated till the consecutive weights obtained were concurrent and the ash was in grayish white colour. Total mineral content of the samples was calculated by using the formula.
Total mineral content of the sample (%) = \( \frac{W_3 - W_1}{W_2} \times 100 \)

Where,

- \( W_3 \) = Weight of crucible with ash
- \( W_1 \) = Weight of crucible
- \( W_2 \) = Weight of sample

5. **Determination of crude fiber content**

Crude fiber content of selected samples was determined by the method of A.O.A.C. (1984).

5.1. **Preparation of reagents**

**0.255 N Sulphuric acid solution**

A measured quantity of 1.25 ml of concentrated sulphuric acid was dissolved in glass distilled water and volume was made up to 100 ml.

**0.313 N sodium hydroxide solution**

A weighed amount of 1.25 g of sodium hydroxide was dissolved in glass distilled water and the volume was made up to 100 ml.

**Procedure**

Exactly 2.0 g of moisture and fat free sample was weighed in triplicate in a 500 ml of beaker. Then 200 ml of 0.255 N sulphuric acid solution was added into each beaker and the mixture was allowed to boil for 30 min keeping the volume constant by the addition of water at frequent intervals, glass rod was used to stir the solution which helped for smooth boiling. Then the mixture was filtered through a muslin cloth and residue was washed with hot water to make it free from acid. The material was then transferred to the same beaker.
carefully; 200 ml of 0.313 N sodium hydroxide was added and boiled for 30 min keeping the volume constant by using distilled water. The mixture was again filtered through a muslin cloth and residue was washed with hot water till it was free from alkali. Then residue was transferred to crucible which was dried in an oven overnight at 80°C and weighed accurately \( W_1 \). The crucible was heated in a muffle furnace at 600°C for 2-3 hours, cooled in a desiccator and weighed again accurately \( W_2 \). The difference between the two weights \( W_1 - W_2 \) was considered as the weight of crude fibre in the moisture and fat free sample. The content of crude fibre in sample was calculated by using following formula

\[
\text{Crude fibre content (\%)} = \frac{100 - (\text{Moisture + fat}) \times \text{weight of Fibre}}{\text{Wt. of sample taken}} \times 100
\]

6. Determination of carbohydrate content (Gopalan et al., 1989)

The content of carbohydrate in the samples was obtained by subtracting from 100, the sum of values of moisture, protein, fat, ash and crude fibre content per 100 g of the sample.

Carbohydrate = 100 - (Moisture + protein + fat + ash + crude fibre)

7. Determination of calcium content

Calcium content of selected samples was estimated by EDTA method.

Preparation of Reagents

4 N sodium hydroxide

It was prepared by dissolving 160 gm of sodium hydroxide (NaOH) in glass distilled water and then volume was made upto 100 ml.
Ammonium purpurate indicator

0.5 g of ammonium purpurate was thoroughly mixed with 100 gm of powdered potassium sulphate.

Ethylene diamine tetra acetic acid (Versenate) solution (0.01N)

2 g of disodium dihydrogen ethylene diamine tetra acetate and 0.05 g of magnesium chloride hexahydrate were dissolved in water and volume was made up to 1000 ml.

Procedure for calcium estimation (A.O.A.C., 1984).

0.5 ml of aliquot of ash solution was taken into beaker and 5 ml of water was added. Then 0.25 ml (5 drops) of 4 N sodium hydroxide and approximately 50 mg of ammonium purpurate indicator were added. It was titrated against 0.01 N EDTA. The end point of titration was noted when 0.01 EDTA produced a colour change from orange red to lavender to purple. The volume of 0.01 EDTA solution required to neutralize the sample was noted.

The calcium content of sample was calculated by formula

\[
\text{Ca (me/lit)} = \frac{R \times \text{Normality of EDTA} \times 1000}{5} \times \frac{\text{Aliquot (ml) taken}}{\text{wt. of sample}} \times \frac{100 \times a}{1000}
\]

\[
\text{Ca (me/100g)} = \frac{20}{1000}
\]

Where,

\[
R = \text{volume (ml) of EDTA used in titration}
\]
7. Determination of iron

The trace elements (iron) from the ash solution of the samples were estimated by atomic absorption spectrophotometer (Perkin R. Elmer Model-3110). The aliquots of each solution were fed to atomic absorption spectrophotometer through a capillary and readings were obtained directly in ppm.

\[
\text{Fe in ppm} = \frac{R \times 100}{\text{Wt. of sample}}
\]

Where,

- \( R \) – the reading on atomic absorption Spectrophotometer

- \( \text{ppm} = \frac{\text{mg}}{1000\text{gm}} \)

- \( \text{Fe in mg/100 g} = \frac{\text{ppm value of Fe}}{10} \)

8. Estimation of micro minerals (copper, zinc and manganese)

(A.O.A.C., 1984)

Wet digestion by nitric acid & microwave and Atomic Absorption Spectrophotometer (AAS)

This procedure is suitable for digestion of a wide range of biological materials and food samples for analysis of Ca, Mg, Zn, Cu and Mn. Use of sealed-chamber digestion vessels in which pressure increases occur during heating have resulted in short digestion time and reduced reagent use.

Materials and reagents
✓ Commercial microwave oven with acid fume vent
✓ PFA digestion vessel
✓ 50 ml digestion tubes
✓ Acid fume hood
✓ Conc. Nitric acid

**Method**

1. Weigh 0.3 g of food sample into 50-mL digestion tube
2. Add 5 mL of concentrated nitric acid
3. Place the digestion tube in the PFA digestion vessel and put it into microwave oven
4. Set the temperature for 150 °C for 30 minutes and then increase the temperature to 180 °C and keep it for 60 mts or until the sample clears
5. Remove the digestion tube from the vessel ones the vessel got cooled
6. Filter the digested sample and makeup the volume upto 100 ml using distilled water
7. The aliquot of the solution were fed to atomic absorption spectrophotometer through a capillary and readings were obtained.

\[
\text{Cu/Zn/Mn in ppm} = \frac{R \times 10}{\text{Wt. of sample}}
\]

Where,

- \( R \) – reading on atomic absorption Spectrophotometer

\[
\text{ppm} = \text{mg/1000g}
\]

\[
\text{Cu/Zn/Mn in mg/100 g} = \frac{\text{ppm value of Cu/Zn/Mn}}{10}
\]