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# Development of Value Added Product from Dehydrated Betel Leaves Powder

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**A B S T R A C T**

The present study was undertaken to determine the sensory quality and nutrient content of khakhra prepared with the incorporation of betel leaves powder both *Kariyele* and *Ambadiyele* at 5, 7.5 and 10% level. Khakhra were prepared by using wheat flour as base ingredient along with betel leaves powder. The developed khakhra were evaluated organoleptically using nine point scale. Khakhra prepared with 5% of *Kariyele* and *Ambadiyele* powder was best acceptable and used for their nutrient computation. Results revealed that khakhra prepared with *Kariyele* powder was found to be high in moisture (12.76%), protein (12.87g) and vitamin-C (2.79mg) whereas *Ambadiyele* khakhra was found to be high in ash (2.23g), crude fiber (2.97g), carbohydrate (69.66g), β- carotene (378.68µg), calcium (215.85mg) and iron (7.30mg). Shelf life study based on sensory evaluation, microbial load and moisture content revealed that both khakhras were acceptable upto 60days of storage under ambient temperature.

## Introduction

India's diverse climate ensures availability of all varieties of fresh fruits and vegetables. India ranks second in fruits and vegetables production in the world, next to China. In India more than 40 kinds of vegetables belonging to different groups, like Solanaceous, Cucurbitaceous, Leguminous, Cruciferous, root crops and leafy vegetables are grown in tropical, subtropical and temperate regions. As per National Horticulture Database published by National Horticulture Board of India, during 2012-13 India produced 162.19 million metric tonnes of vegetables with cultivated area of 9.21 million hectares. The leafy vegetables are highly perishable in nature and have very short shelf life. Green leafy vegetables (GLV) represent an excellent component of the habitual diet in the tropical and temperate countries. Vegetables are important protective foods and highly beneficial for the maintenance of health and prevention of disease. Green leafy vegetables occupy an important place among the food crops as these provide adequate amounts of many vitamins and minerals (Kakade and Neeha, 2014).

The fresh leaves of betel vine are popularly known as Paan in India the scientific name of betel vine is *Piper betel*L. It belongs to the family *Piperaceae*, The vine is a dioecious (male and female plants are different), shade loving perennial root climber. There are about 100 varieties of betel vine in the world, of which about 40 are found in India and 30 in West Bengal and the origin of betel vine is Malaysia. Betel leaves are consumed by about 15-20 million people in the country. It is cultivated following the traditional methods in India on about 55,000 ha with an annual production worth about Rs 9000 million. (Guha, 2006). Leaves are rich source of many antioxidants *viz.* flavonoids, terpenoids, tannins, alkaloids, saponins *etc*. *Piper betel* helps in curing various diseases like hypertension, diabetes, brain toxin, boils and abscesses, headache, leucorrhoea, cuts and injuries, ringworm infestation, swelling of gum, voice problems, rheumatism, wound healing, obesity, conjunctivitis, constipation, abrasion *etc*. (Aishwarya *et al.*, 2016).

Betel vine is one of the invaluable medicinal plants, leaves are used for many medicinal purposes and has been described from ancient time as an aromatic stimulo-carminative, astringent and aphrodisiac (Sripradha, 2014) Despite of high nutritional value they are not utilized to the extent they should be, because they are highly seasonal, perishable and have short shelf life. Among various methods of preservation, dehydration is one of the most popular and method. Dehydration increases the storage period of GLV and make them available throughout the year even in off-season, thus, supplies the important nutrients in a concentrated form. Dehydrated foods are more concentrated source of minerals than any other preserved form of food stuff (Singh *et al.*, 2007). Betel leaves can be easily dehydrated and added in various food products in order to increase their nutritive value. Therefore, the present study was undertaken to develop Khakhra from dehydrated both *Kariyele* and *Ambadiyele* betel leaves.

## Materials and Methods

The two varieties of betel leaves *i.e. Kariyele* and *Ambadiyele* required for research work were procured from the local market of Bengaluru. The damaged, discoloured leaves were manually separated and fresh, green leaves were selected, washed in tap water to remove extraneous matter. Leaves were finely chopped, weighed and then they were dried in hot air oven at $60^0$ C for 3 hours. The dehydrated leaves were powdered and were subjected to nutrient analysis. Moisture, protein, fat, crude fiber, ash, carbohydrate, energy, potassium, sodium, iron and zinc were estimated using standard methods(AOAC,1980).Calcium content was determined by titration method described by (Heau *et al.*, 1965). β-carotene by spectrophotometer method (Ranganna, 2002), vitamin-C by titration method using iodate solution (Tauber and Kleiner, 1935), antioxidant activity by DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging activity method (Kang and Saltveit, 2002) and Phosphorus by atomic spectrophotometer (Adelowo *et al.*, 2016). Khakhra was prepared by incorporating dehydrated betel leaves powder both *Kariyele* and *Ambadiyele*. Nutrient composition of the best accepted Khakhra was computed based on the nutritional composition of the ingredients (Gopalan *et al.*, 2014). Storage study was done for the khakhra based on sensory evaluation, moisture content and microbial load.

## Results and Discussion

### Nutritional analysis of dehydrated betel leaves powder

The findings of nutritional analysis of dehydrated betel leaves powder is presented in

Table 1. It was found that dehydrated *Kariyele* powder had 13.53 percent moisture, 13.47g protein, 4.46g fat, 14.66g total ash, 5.2g crude fiber, 48.63g carbohydrate and 288.54 Kcal energy.β-carotene5440µg, vitamin C34.73mg and antioxidant content 43.01mg respectively. Minerals i.e. calcium, potassium, sodium, phosphorus, iron and zinc contents were 2018.8mg,4054 mg, 32.83 mg, 213, 23.15mg and 4.65mg respectively. Whereas Dehydrated *Ambadiyele* powder had 12.66 percent moisture, 12.07g protein and 4.62 g fat. Amount of total ash was 15.33 g, crude fibre 6.5 g, carbohydrate48.82 g and energy 285.14 Kcal. β-carotene, vitamin C and antioxidant contents were 6693 µg, 32.86 mg and 39.81mg respectively and calcium 2894.2 mg, potassium 3822.3 mg, sodium 24.3mg, phosphorus 242.3 mg, iron 40.98 mg and zinc 6.75 mg. Moisture, protein, energy, vitamin-C, potassium and sodium were higher in *Kariyele* powder. The results were in accordance with Chauhan and Aishwarya (2016), who reported the nutrient content of dried betel leaves powder moisture 9.45%, protein 3.30%, fat 1.10%, fiber 10.15%, ash 6.87%, carbohydrate 63.92%, vitamin C, iron and calcium as 1.11%, 2.57% and 1.53% respectively on fresh weight basis. These values are lower than present study values except for fiber and carbohydrate, which might be due to difference in variety, drying condition and climatic conditions.

## Development of Khakhra

Khakhra was prepared from both *Kariyele* and *Ambadiyele*. Table 2 shows the formulation of the developed Khakhra using dehydrated betel leaves powder. Sensory evaluation was done to check acceptance of the products using nine point hedonic scale by 21 semi-trained panel members.

Khakhra is also referred as crispy chapatti or roti. It is a common Gujarati Indian bread or snack item served during breakfast or snack time. It is simple to prepare and is made from whole wheat flour adding other ingredients and spices. It is also light weight and easily stored and packed (Verma and Bhatnagar, 2017). Three variations of khakhras were prepared by incorporating *Kariyele* powder and *Ambadiyele* powder at different levels *i.e.* 5, 7.5 and 10 per cent. Both *Kariyele* khakhra (BKK 1) and *Ambadiyele* khakhra (BAK1) was found to be best accepted at 5 percent incorporation with scores for appearance 8.23 and 8.19, colour 8.04 and 7.95, texture 8.09 and 8.42, aroma 8.38 and 8.33, taste 8.19 and 8.04 and overall acceptability 8.14 and 8.38 respectively. And control had scores for appearance, colour, texture, aroma, taste and overall acceptability as 8.47, 8.33, 8.23, 8.23, 8.14 and 8.19 respectively. The mean sensory scores of best accepted khakhra are given in Figure 1.

## Nutrient composition of best accepted Khakhras

Nutrient composition of best accepted products and control were computed and presented in Table 4. It was found that *Kariyele* khakhra (BKK 1) was rich in moisture 12.76 per cent, protein 12.87, vitamin- C 12.79 mg. Whereas *Ambadiyele* khakhra (BAK1) had higher ash 2.23g, crude fiber 2.97g, β- carotene 378.68µg, calcium 215.85mg and iron 7.30mg. Both *Kariyele* and *Ambadiyele* khakhra had 12.29g fat content. Compared to betel leaves khakhra control had higher carbohydrate 70.69 and energy 444.78 Kcal because in betel leaves khakhra 5g of wheat flour was replaced with 5 per cent betel leaves powder.

## Shelf life study of the developed products

Best accepted *Kariyele* (BKK1) and *Ambadiyele* (BAK1) Khakhras along with control were packed in aluminium pouches

and stored at room temperature. The samples were subjected for sensory evaluation, moisture content and microbial load on initial, 15th, 30th, 45th and 60th day.

Table 3 depicts mean sensory scores of betel leaves khakhra from initial day to end of storage period *i.e.* 60th day. Results revealed that there was decrease in the sensory scores during storage period. The decrease in appearance score was from 8.47 to 7.71, colour from 8.33 to 7.66, texture from 8.23 to 7.71, aroma from 8.23 to 7.57, taste from 8.14 to 7.61 and overall acceptability was from 8.19 to 7.57 in control. Whereas BKK1 and BAK1 showed decrease of 8.23 to 7.52 and 8.19 to 7.52 respectively for appearance, 8.04 to 7.38 and 7.95 to 7.28 for colour, 8.09 to 7.42 and 8.42 to 7.57 for texture, 8.38 to 7.52 and 8.33 to 7.52 for aroma, 8.19 to 7.47 and 8.04 to 7.57 for taste and 8.14 to 7.66 and 8.38 to 7.76 for overall acceptability respectively. All three types of khakhras were acceptable even after 60 days of storage period. Scores for all sensory parameters decreased with increasing number of days of storage and this might be due to change in flavour and reduced crispiness of the khakhras. However khakhras were acceptable till 60 days. The results are in line with the study conducted by Punia and Gupta (2009) who reported that the sensory scores of the products *i.e.* soya ladoo, paushtikladoo, sev and mathi slightly decreased and free fatty acids, peroxide value and total sugar increased with the increase in storage period.

**Fig.1** Mean sensory scores for best accepted khakhra

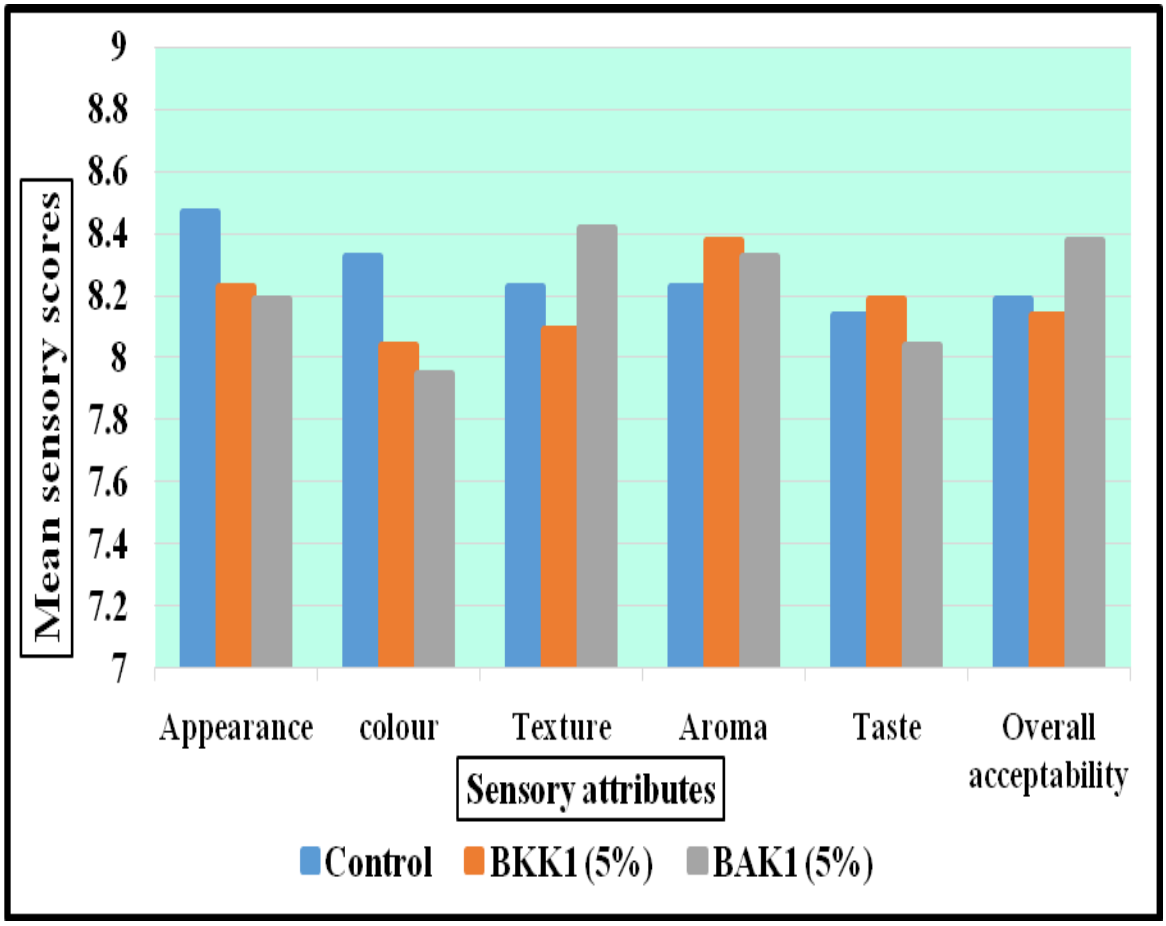

**Fig.2** Mean moisture content of khakhra during storage

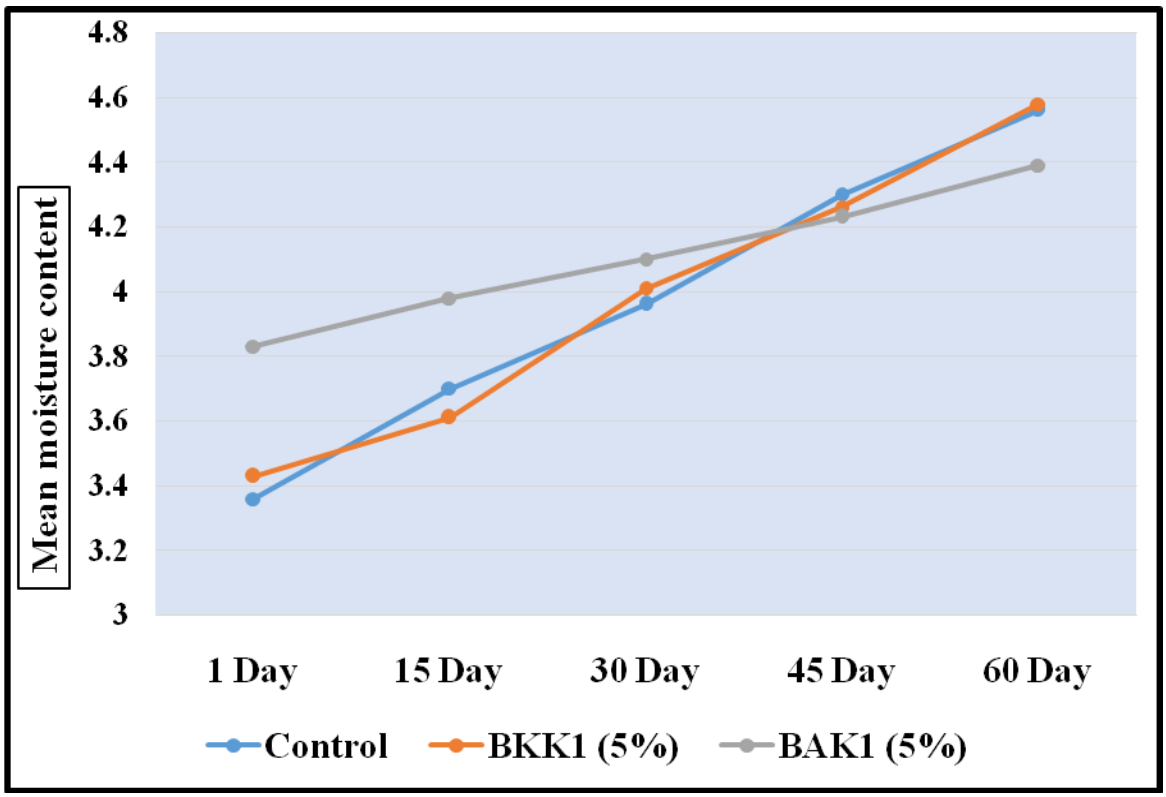


**Table.1** Nutritional composition of dehydrated betel leaves powder (Per 100g dry weight)

| Nutrients | *Kariyele* | *Ambadiyele* |
|---|---|---|
| Moisture (%) | 13.53 | 12.66 |
| Protein (g) | 13.47 | 12.07 |
| Fat (g) | 4.46 | 4.62 |
| Total ash (g) | 14.66 | 15.33 |
| Crude fiber (g) | 5.2 | 6.5 |
| Carbohydrate (g) | 48.63 | 48.82 |
| Energy (Kcal) | 288.54 | 285.14 |
| **Vitamins** | | |
| β – carotene (µg) | 5440 | 6693 |
| Vitamin C (mg) | 34.73 | 32.86 |
| **Minerals** | | |
| Calcium (mg) | 2018.8 | 2894.2 |
| Potassium (mg) | 4054 | 3822 |
| Sodium (mg) | 32.83 | 24.3 |
| Phosphorus (mg) | 213 | 242.3 |
| Iron (mg) | 23.15 | 40.98 |
| Zinc (mg) | 4.65 | 6.75 |

**Table.2** Development of betel leaves khakhra

| Ingredients | Quantity (g) | |
|---|---|---|
| | CONTROL | I |
| Wheat flour | 100 | 95 |
| Cumin seeds | 1 | 1 |
| Cumin powder | 1 | 1 |
| Chilli powder | 2 | 2 |
| Turmeric powder | 0.5 | 0.5 |
| Salt | 2 | 2 |
| Oil | 10 | 10 |
| Betel leaves dehydrated powder | - | 5 |

I – Betel leaves (*Kariyele* and *Ambadiyele*) powder at 5% level

**Table.3** Mean sensory score of betel leaves khakhra during shelf life study

| Products | Duration | Appearance | Colour | Texture | Aroma | Taste | Overall Acceptability |
|---|---|---|---|---|---|---|---|
| Control | Initial | 8.47 | 8.33 | 8.23 | 8.23 | 8.14 | 8.19 |
| | 15$^{th}$ day | 8.33 | 8.28 | 8.19 | 8.09 | 8.04 | 8.14 |
| | 30$^{th}$ day | 8.14 | 8.04 | 7.90 | 7.95 | 7.85 | 7.80 |
| | 45$^{th}$ day | 7.95 | 7.80 | 7.85 | 7.76 | 7.71 | 7.66 |
| | 60$^{th}$ day | 7.71 | 7.66 | 7.71 | 7.57 | 7.61 | 7.57 |
| | F value | * | * | NS | * | * | * |
| | SEm± | 0.11 | 0.13 | 0.14 | 0.10 | 0.13 | 0.12 |
| | CD at 5% | 0.33 | 0.36 | - | 0.29 | 0.38 | 0.35 |
| BKK1 (5%) | Initial | 8.23 | 8.04 | 8.09 | 8.38 | 8.19 | 8.14 |
| | 15$^{th}$ day | 8.14 | 7.95 | 7.95 | 8.23 | 8.00 | 8.04 |
| | 30$^{th}$ day | 7.95 | 7.80 | 7.76 | 7.90 | 7.85 | 7.90 |
| | 45$^{th}$ day | 7.76 | 7.61 | 7.57 | 7.71 | 7.66 | 7.76 |
| | 60$^{th}$ day | 7.52 | 7.38 | 7.42 | 7.52 | 7.47 | 7.66 |
| | F value | * | * | * | * | * | * |
| | SEm± | 0.12 | 0.14 | 0.12 | 0.11 | 0.13 | 0.10 |
| | CD at 5% | 0.34 | 0.41 | 0.35 | 0.32 | 0.36 | 0.29 |
| BAK1 (5%) | Initial | 8.19 | 7.95 | 8.42 | 8.33 | 8.04 | 8.38 |
| | 15$^{th}$ day | 8.14 | 7.85 | 8.28 | 8.09 | 7.95 | 8.23 |
| | 30$^{th}$ day | 7.95 | 7.66 | 8.09 | 7.85 | 7.76 | 8.09 |
| | 45$^{th}$ day | 7.71 | 7.47 | 7.76 | 7.61 | 7.71 | 7.85 |
| | 60$^{th}$ day | 7.52 | 7.28 | 7.57 | 7.52 | 7.57 | 7.76 |
| | F value | * | * | * | * | * | * |
| | SEm± | 0.15 | 0.11 | 0.14 | 0.12 | 0.11 | 0.13 |
| | CD at 5% | 0.42 | 0.33 | 0.40 | 0.35 | 0.33 | 0.38 |

*- Significant at 5% level, NS – Non significant, BKK1 – Betel leaves *Kariyele* khakhra 1 BAK1 – Betel leaves *Ambadiyele* khakhra 1

**Table.4** Nutrient composition of best accepted products

| Nutrients | Khakhra | | |
|---|---|---|---|
| | Control | BKK1 | BAK1 |
| Moisture | 12.70 | 12.76 | 12.72 |
| Protein (g) | 12.81 | 12.87 | 12.83 |
| Fat (g) | 12.15 | 12.29 | 12.29 |
| Ash(g) | 1.54 | 2.20 | 2.23 |
| Crude fiber (g) | 2.75 | 2.91 | 2.97 |
| Carbohydrate | 70.69 | 69.65 | 69.66 |
| Energy (K cal) | 444.78 | 442.17 | 441.98 |
| β – carotene | 44.22 | 321.08 | 378.68 |
| Vitamin C | 1.06 | 2.79 | 2.70 |
| Calcium (mg) | 73.55 | 172.05 | 215.85 |
| Iron (mg) | 5.519 | 6.42 | 7.30 |

BKK1 – Betel leaves *Kariyele* khakhra 1(5%), BAK1 – Betel leaves *Ambadiyele* khakhra 1 (5%)
BKK1 – Betel leaves *Kariyele* khakhra 1 BAK1 – Betel leaves *Ambadiyele* khakhra 1

**Table.5** Microbial population of betel leaves khakhra at different intervals

| | | Duration | | | | | |
|---|---|---|---|---|---|---|---|
| **Bacteria (×10² CFU/g)** | | 0 | 15th day | 30th day | 45th day | 60th day | Mean |
| | Control | 0.00 | 0.63 | 2.10 | 4.80 | 8.00 | 31.26 |
| | BKK1 | 0.00 | 0.33 | 1.50 | 3.56 | 7.40 | 25.73 |
| | BAK1 | 0.00 | 0.46 | 1.86 | 3.86 | 7.6 | 27.66 |
| | Mean | 0.00 | 4.77 | 18.44 | 40.88 | 77.00 | |
| | | F – Value | | SEm± | | CD @ 5% | |
| | Treatments | * | | 0.57 | | 1.65 | |
| | Duration | * | | 0.73 | | 2.13 | |
| | T× D | * | | 1.27 | | 3.70 | |
| **Moulds (×10² CFU/g)** | | 0 | 15th day | 30th day | 45th day | 60th day | Mean |
| | Control | 0.00 | 0.16 | 0.30 | 0.73 | 1.06 | 4.46 |
| | BKK1 | 0.00 | 0.06 | 0.20 | 0.53 | 0.90 | 3.40 |
| | BAK1 | 0.00 | 0.06 | 0.26 | 0.56 | 0.96 | 3.73 |
| | Mean | 0.00 | 0.88 | 2.55 | 6.11 | 9.77 | |
| | | F – Value | | SEm± | | CD @ 5% | |
| | Treatments | NS | | 0.40 | | - | |
| | Duration | * | | 0.52 | | 1.51 | |
| | T× D | NS | | 0.90 | | - | |
| **Coliforms (×10² CFU/g)** | | 0 | 15th day | 30th day | 45th day | 60th day | Mean |
| | Control | 0.00 | 0.00 | 0.16 | 0.36 | 0.50 | 2.00 |
| | BKK1 | 0.00 | 0.00 | 0.06 | 0.20 | 0.30 | 1.20 |
| | BAK1 | 0.00 | 0.00 | 0.10 | 0.30 | 0.40 | 1.66 |
| | Mean | 0.00 | 0.00 | 1.33 | 2.77 | 4.00 | |
| | | F – Value | | SEm± | | CD @ 5% | |
| | Treatments | * | | 0.17 | | 0.51 | |
| | Duration | * | | 0.22 | | 0.66 | |
| | T× D | NS | | 0.39 | | - | |

*Significant ($p \leq 0.05$), NS – Non significant, BKK1- Betel leaves *Kariyele* khakhra, BAK1- Betel leaves *Ambadiyele* khakhra

**Table.6** Mean moisture content of betel leaves khakhra during shelf life study

| Duration | Moisture content | | |
|---|---|---|---|
| | Control | BKK1 | BAK1 |
| Initial | 3.36 | 3.43 | 3.83 |
| 15$^{th}$ day | 3.70 | 3.61 | 3.98 |
| 130$^{th}$ day | 3.96 | 4.01 | 4.10 |
| 45$^{th}$ day | 4.30 | 4.26 | 4.23 |
| 60$^{th}$ day | 4.56 | 4.58 | 4.39 |
| F value | * | * | * |
| SEm ± | 0.06 | 0.05 | 0.07 |
| CD at 5% | 0.21 | 0.18 | 0.22 |

*- Significant at 5% level, NS – Non significant, BKK1 – Betel leaves *Kariyele* khakhra 1, BAK1 – Betel leaves *Ambadiyele* khakhra 1

Results of microbial population estimated for total bacteria, moulds and coliforms by standard plate count method are presented in Table 5. The data related to bacterial population showed increasing trend in all variations throughout the storage period, but increase in betel leaves incorporated khakhra were lower compared to control. Results indicate that significant differences exist among all the variations at all stages of storage period for bacterial population. BKK1 treatment had significant low population of bacteria, leading to conclusion that BKK1 has more antibacterial properties.

Population of moulds in control sample was significantly higher than other variations whereas BKK1 and BAK1 samples were on par with each other. Supplementation of *Kariyele* or *Ambadiyele* did not have any impact on mould population. The data pertaining to coliform population of khakhra BKK1 and BAK1 had significantly low population of coliform because betel leaves incorporation inhibited coliform growth compared to control hence, BKK1 found better compared to others. Similar results were observed by Rajamani and Raajeswari (2015) that khakhra witnessed a microbial load of 7 colonies at 10 $^{-7}$ dilution on the first day while on the third day the number of colonies increased to 10 colonies. There was no fungal and coliform growth even after three days of storage. This could be attributed to very low moisture content of the product. But in the present study, very slight increase in microbial growth i.e. total bacterial count, moulds and coliforms were observed for best accepted betel leaves khakhra (BKK1 and BAK1) as well as control during 60 days of storage period. But microbial load of the developed products were within consumption limit. This could be due to application of heat during preparation of khakhra in addition to its low moisture content.

Moisture content of best accepted khakhra was analysed and presented in Table 6 and Figure 2. The moisture content of the khakhras increased with increasing storage period. For control it was 3.36% initially and 3.70, 3.96, 4.30, 4.56% on 15$^{th}$, 30$^{th}$, 45$^{th}$ and 60$^{th}$ day of storage. For *Kariyele* khakhra (BKK1) it was 3.43% initially and 3.61, 4.01, 4.26 and 4.58% on 15$^{th}$, 30$^{th}$, 45$^{th}$ and 60$^{th}$ day of storage respectively. Even in case of *Ambadiyele* khakhra (BAK1) moisture content was increased from 3.83% initially to 4.39% on 60$^{th}$ day of storage. Statistically significant difference was observed in

khakhras during 60 days of storage period. Similarly, Reddy *et al.,* (2014) reported change in moisture content of extruded Ready To Eat (RTE) snacks using corn, black gram, roots and tubers flour blends for the storage period of 2 months. Increase in moisture content of extruded products ranged from 2.14 to 3.29 g% at the end of 2 month storage period which was desirable for extruded snacks to maintain crispiness. Authors reported that increase in moisture content may be due to more air spaces in the RTE extruded products on storage.

Sirpatrawn (2008) also reported that moisture content of rice crackers increased during storage period. According to investigator, change in water content directly causes the textural change due to loss of crispness. This may be due to certain factors such as storage temperature, relative humidity and the sorption properties of the product.

It can be concluded from the results that the shelf stable and acceptable value added products can be developed by incorporating dehydrated betel leaves (*Kariyele* and *Ambadiyele*) in conventional food items and can enrich the nutritional quality of the products as well as it adds variety to the diet.

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