**Effect of Packaging Materials on Storage Quality of Functional Beverage Mix**

## Abstract:

Finger millet based functional beverage mix was developed with 9% ~~of~~ green banana flour and 1% ~~of~~ ginger powder.The developed beverage mix was packed by using four different packaging materials i.e., Low density polyethylene (P1), Standup pouch (P2), Aluminium foil pouch (P3) and Polyethylene terephthalate bottles (P4) and stored at room temperature. ~~and then~~ The changes in the physico-chemical, microbial quality was analysed for the period of 3 months (90 days). During storage the moisture content was increased from 6.23 to 6.99%, whereas other chemical properties *viz.,* carbohydrate (CHO), protein, fat, ash and dietary fiber were gradually decreased from 68.62 to 68.48, 15.09 to 14.99, 1.50 to 1.48, 3.74 to 3.73 and 2.78 to 2.77 respectively. There was non-significant difference of calcium (644.28 to 644.27) and phosphorus (506.47 to 506.56) observed in all the packaging materials during storage. The low microbial load observed in P3 and P4 packed beverage mix during storage. The study revealed that the functional beverage mix packed in polyethylene terephthalate bottles was undergone minimum changes in physico-chemical characteristics. Hence, it is concluded that the storage of functional beverage mix in polyethylene terephthalate bottles extent the shelf life of the product and reduce the nutrient losses during storage.

Keywords: Finger millet milk powder, Green banana flour, Lactose intolerance, Packaging materials, Storage period.

## Introduction:

 Finger millet or ragi (*Eleusine coracana*) is the oldest cereal grain in India which is fairly grown in extreme climatic conditions such as dry soil and poor fertilizer (Singh *et al.,* 2018). It contains about 5-8% protein, 65-75% carbohydrates, 15-20% dietary fiber and 2.5-3.5% minerals. It has the highest calcium content among all cereals (344 mg/100 g) which is thirty times more than that of rice and wheat. However, the mill*et al*so contains phytates (0.48%), polyphenols, tannins (0.61%) (Bansal and Kaur, 2018). These antinutritional properties are removed by using different processing methods such as soaking, germination, boiling and roasting. Due to its nutritional value this crop is referred as "poor people's crop"(Srivastava and Sharma 2012).

 The plant based foods especially finger millet is very important source of calcium for lactose intolerance people. Lactose intolerance is a condition in which people have digestive symptoms such as bloating, diarrhea, and gas after eating or drinking milk or milk products (Harvey *et al.,* 2018). The amount of lactose that causes the symptoms varies from person to person, depending on the amount of lactose consumed, the degree of lactase deficiency and the form of the product/food product in which lactose is ingested. About 75% of the world's adult population is lactose-intolerant (Deora and Deswal, 2018). The only treatment for people with lactose problems is adherence to foods without lactose. Therefore, taking into account all points, we tried to examine the above considerations before developing functional foods for patients with lactose intolerance,

 Hence, the present study is to develop plant based functional beverage mix for lactose intolerance people. Here, instead of using finger millet, finger millet milk powder is used along with other functional ingredient *viz.,* greenbanana flour and ginger for the preparation of functional beverage and studied the effect of packaging materials [LDPE (P1), standup pouch (P2), Aluminium foil (P3) and PET bottle (P4)] on physico-chemical and microbial quality of the product during 3 months of storage.

## Materials and methods:

### *Preparation of functional beverage mix*

 The raw materials such as finger millet, green banana, and ginger were procured from local market. All the ingredients were subjected to different required processing steps *viz.,* soaking, blanching, drying, grinding and roasting and all the ingredients were mixed with standardized proportion for development of functional beverage mix. The composition of functional beverage mix is 90 g of finger millet milk powder, 9 g of green banana flour and 1 g of ginger powder.

### *Packaging materials*

The packaging materials used for the study are low density polyethylene, standup pouch, aluminium foil pouch and polyethylene terephthalate bottle which are procured from supermarket in Madurai.

### *Organoleptic evaluation of beverage mix*

Quality parameters such as colour, flavour, texture and overall acceptability of the beverage mixes were evaluated by 20 panelists including lactose intolerance people. Nine point hedonic rating score card was used for organoleptic evaluation of the beverage with the developed mix ([Srilakshmi 2005](#_ENREF_107)).

### *Physico-chemical properties*

 Moisture, CHO, protein, fat, ash, dietary fiber, calcium and phosphorus were estimated as per standard procedure given by AOAC method.

### *Microbial quality*

The growth of microorganism in functional beverage mix was carried out by adopting standard procedure of serial dilution and pour plate method for 3 months of storage period. one g of sample was added into 9 ml of sterile water and thoroughly mixed and then serial dilution was done from 10-1 to 10-6. Here, the 10-3, 10-1 and 10-1 dilutions were taken and used it for further examination of microbes (Bacteria, Fungi and Yeast) in the sample. From this dilution, 1 ml of sample was poured into petriplate and then 15 ml of required media was added for particular microorganism and rotated in clockwise and anticlockwise direction for uniform spreading of the sample. After solidification of the media, the pertiplates were incubated for 24 hr for bacteria, 2 - 3 days for fungi and 5 days for yeast at ambient temperature. The colonies were examined and expressed as colony forming unit per gram of sample (cfu/ ml).

### *Statistical analysis*

 The data observed from the study were subjected to statistical analysis to find out the effect of packaging materials on quality of the developed product during storage by using AGRES software.

## Results and discussions:

### *Organoleptic evaluation of beverage mix during storage*

 The sensory attributes of beverage mix is shown in Figure.1. The slight changes of colour and appearance (7.8 - 8.2), flavor (7.8 - 8.1), consistency (7.6 - 7.8), taste (7.8 - 8.0) and overall acceptability (7.5 – 8.0) observed in P1 and P2 packed beverage mix during 3 months of storage. This might be due to increased moisture content, hydrolysis and oxidation of nutrients which decrease its sensory score. There was non-significant changes observed in P3 and P4 packed beverage mix during storage due to less moisture absorption. Arokiamary *et al.,* (2020) stated that supplementary food mix packed with PET jars had highly acceptable sensory score during the storage period (180 days). The similar findings reported by Swaminathan and Guha, (2018).

Figure.1 Sensory attributes of beverage mix during storage

### *Title- Changes in sensory attributes of functional beverage mix during storage*

### *X axis- Storage period*

### *Physico-chemical properties of beverage mix*

The initial and final moisture content of the functional beverage mix is presented in Table. 1. The initial moisture content of beverage mix was 6.23 %. During storage, the moisture content was increased to a minimum of 6.62 % in P4. Moisture permeability rate was significantly (p<0.05) very low in P3 (0.39 %) and P4 (0.21 %) packed samples and higher permeability was shown in P1 (0.74 %) and P2 (0.52 %) packed samples during storage period which was checked at regular interval. The increase in moisture content might be due to absorption of moisture content from atmosphere via diffusion of vapour from minute pores of packaging materials during storage period Dhiman *et* *al*., (2017). The non significant difference (p>0.05) observed between the packaging material and storage periods. Arokiamary *et al.,* (2020) reported that the moisture content of supplementary food mix packed in PET bottles showed less moisture absorption (6.35 %) when compared to polyethylene pouches (6.64 %). Swaminathan and Guha (2018) stated that the moisture content of rice beverage mix gradually increased from 7.2 - 7.7 % in 90 days of storage period when packed in aluminium laminate foil (ALF) and metalized polyethylene terephthalate. The ALF packed rice beverage mix showed low moisture permeability.

 The initial and final carbohydrate content of beverage mix found to be 68.62 - 68.48 g/100g in P4. (Table. 1). A very low change of carbohydrate content was observed in P3 and P4 packed beverage mix. The reduction rate of carbohydrate content was found in different packaging materials and the values are P1 (1.79 %), P2 (1.52 %), P3 (1.13 %) and P4 (0.14 %) packed samples. The change in carbohydrate content observed during storage is mainly due to increasing amount of moisture content which converts the complex sugars into simple sugar. The non significant difference (p>0.05) observed between the packaging material and storage periods. Sangma *et al.,* (2019) stated that ready to cook malt mix had carbohydrate content of 72.34 g/100g when stored in aluminium foil pouch upto 6 months with good nutrient retention. The similar results found previous study also Dhiman *et al.,* (2017).

 In the first month of storage, beverage mix had protein content of 15.09 g/100g respectively (Table. 1). During storage, the protein content got reduced to 0.10 to 0.20 % (sample code). A gradual decrease of protein content was observed in P1 and P2 packaging material compared to P3 and P4 packed beverage mix. The slight decrease in protein content is due to degradation of protein because of increasing moisture content and maillard reaction is a major cause in storage period. There was no significant changes (p>0.05) observed between packaging materials and storage period. Dhiman Anju (2017) estimated the protein content of instant mix from dehydrated pumpkin decreased from 10.41 to 9.55 % and concluded that the mix packed in aluminium foil pouch showed more protein retention when compared to polyethylene pouches. Rokhsana *et al.,* (2007) developed the instant pulse based powder which had protein content of 19.40 % and reported that the reduction in protein content was very minimum in polyethylene packed powder. These results are ~~were~~ highly correlated with current investigation.

 The fat content of beverage mix found to be 1.50 % at initial month of storage period. During storage, the fat content decreased from 1.50 - 1.45 % (Table. 2). The low reduction was observed in polyethylene terephthalate (PET) packed beverage mix. The non significant difference (p>0.05) observed between the packaging material and storage periods. According to [Dhiman Anju (2017](#_ENREF_29)) the decreased percent of fat content (6.50 - 6.37 %) was observed in instant halwa mix during six months of storage period. According to [Dhiman Anju (2017](#_ENREF_29)) the decreased percent of fat content (6.50 - 6.37 %) was observed in instant halwa mix packed in LDPE during six months of storage. [Dhiman *et al.,* (2017](#_ENREF_30)) reported that fat content of instant soup mix was reduced with increase in storage period this was in the range of 1.15 to 1.26 %. The slight variation might be due to hydrolysis of fat and the oxidation of flour because of increasing percent of moisture content during storage. These results are more similar to present investigation.

 The initial dietary fiber content of control and beverage mix (T4) was 0.70 and 3.74 % respectively (Table. 2). The gradual reduction of dietary fiber was observed during storage that was 0.65 - 3.68 % which was packed in P1 and P2 packaging material and slight change was observed in P3 and P4 packed beverage mix. The gradual reduction of dietary fiber was observed in the all the treatments but the reduction was slightly lower in P3 (0.02 %) and P4 (0.01 %) packed samples than P1 (0.07 %) and P2 (0.05 %) during storage period. The average reduction rate of dietary fiber among packaging materials was 0.038 % in beverage mix during storage. The non significant difference (p>0.05) observed between the packaging material and storage periods. [Swaminathan and Guha (2018](#_ENREF_110)) stated that dietary fiber content of protein rich rice mix is 6.93 % and very low reduction rate was observed during 3 months of storage.

 The ash content of beverage mix was found to be 6.90 g/100g at initial month of storage (Table. 2). A non significant reduction (p>0.05) in mineral content was observed between packaging materials and storage periods. A very minute decrease in mineral contents might be due to interaction of these with other nutrients like protein and carbohydrate ([Hussain *et al.,* 2010](#_ENREF_42)). [Rokhsana *et al.,* (2007](#_ENREF_87)) revealed that there is no reduction observed in ash content of the sample during 6 months of storage period. The similar trend was observed in studies of [Vashistha *et al.,* (2019](#_ENREF_118)). [Karuppasamy *et al.,* (2013](#_ENREF_48)) reported there was no change observed in ash content (0.01 %) of composite mix during 90 days of storage. These findings are more correlated with current investigation.

Table.1. Physico-chemical properties (Moisture, CHO and Protein) of beverage mix during storage

|  |  |  |  |
| --- | --- | --- | --- |
| Physico-chemical properties | Moisture | CHO | Protein |
| Packaging materials | Initial | Final | Initial | Final | Initial | Final |
| P1 | 6.23 | 6.99 | 68.62 | 66.85 | 15.09 | 14.92 |
| P2 | 6.23 | 6.95 | 68.62 | 67.19 | 15.09 | 14.95 |
| P3 | 6.23 | 6.93 | 68.62 | 67.32 | 15.09 | 14.98 |
| P4 | 6.23 | 6.62 | 68.62 | 68.48 | 15.09 | 14.99 |
| Particulars | SED | CD (0.05) | SED | CD (0.05) | SED | CD (0.05) |
| P | 0.06773 | 0.13978\*\* | 0.82199 | 1.169652 NS | 0.13563 | 0.27992 NS |
| S | 0.04789 | 0.09884NS | 0.581124 | 1.19962 NS | 0.09590 | 0.19794 NS |
| PS | 0.09578 | 0.19768NS | 1.16248 | 2.39924 NS | 0.19181 | 0.39587 NS |

Table.2. Physico-chemical properties (Fat, Dietary fiber and Ash) of beverage mix during storage (3 months – 90 days)

|  |  |  |  |
| --- | --- | --- | --- |
| Physico-chemical properties | Fat | Dietary fiber | Ash |
| Packaging materials | Initial | Final | Initial | Final | Initial | Final |
| P1 | 1,50 | 1.45 | 3.74 | 3.68 | 2.78 | 2.75 |
| P2 | 1.50 | 1.46 | 3.74 | 3.72 | 2.78 | 2.75 |
| P3 | 1.50 | 1.47 | 3.74 | 3.72 | 2.78 | 2.76 |
| P4 | 1.50 | 1.48 | 3.74 | 3.73 | 2.78 | 2.77 |
| Particulars | SED | CD (0.05) | SED | CD (0.05) | SED | CD (0.05) |
| P | 0.01097 | 0.02263 NS | 0.03629 | 0.07490 NS | 0.03426 | 0.07071 NS |
| S | 0.00775 | 0.01600 NS | 0.02566 | 0.05296 NS | 0.02423 | 0.05000 NS |
| PS | 0.01551 | 0.03201 NS | 0.05132 | 1.10592 NS | 0.04845 | 0.10000 NS |

### *Microbial quality of beverage mix during storage:*

 The microbial population of beverage mix was carried out during storage period of 3 months at regular interval. According to observation there was no growth of bacteria ~~was found~~ at initial stage of developed product in all the packaging materials. In 2nd month no growth was observed in aluminium foil pouches (P3) and PET bottles (P4) packed beverage mix, whereas P1 and P2 packed beverage mix had very low bacterial count that is 1.3 × 10-3 and 1.0 × 10-3 cfu/ ml. The bacterial population slightly increased in all the packaging materials 2.2 - 2.4 ×10-3 cfu/ ml respectively for beverage mix at the end of storage month. [Arokiamary *et al.,* (2020](#_ENREF_9)) stated that the bacterial load of supplementary food mix was found to be 3.0 x 105 cfu/ g and it was increased to 6.0 x 105 cfu/ g after 90 days of storage period. [Khan *et al.,* (2014](#_ENREF_51)) reported that the instant porridge mix had 100 - 150 colonies/ g at initial stage and 200 - 400 colonies/ g at 120 days of storage period which was very higher than this study. [Senthil *et al.,* (2011](#_ENREF_96)) reported that the bacterial count of instant mix ranged from 5.90 - 6.00 Log 10 cfu/g. It was inferred that the low bacterial count of beverage mix might be due to low moisture content and the presence of anti-microbial substances in ginger powder.

 The fungal growth was not observed in freshly prepared functional beverage mixes. There was no growth of fungi ~~observed~~ upto 2 months of storage period. In last month of storage the fungal count was increased slightly in P1 and P2 packed beverage mix. The fungal count was found to be 1.0×10-1 cfu/ ml in P1 and P2 packed samples at 2 months of storage period. The very low fungal count was observed in during storage that is 1.0×10-1 cfu/ ml in both P1 and P2 packed beverage mix. There was no fungal count observed in P3 and P4 packed beverage mix. [Arokiamary *et al.,* (2020](#_ENREF_9)) described that the fungal count of supplementary food mix was observed to be 2.0 - 3.0 x 103 cfu / g at 60 days of storage period which was higher when compared to the present study. [Khan *et al.,* (2014](#_ENREF_51)) was noted that there was less than 100 colonies/ g of fungal count observed in instant porridge mix during 120 days of storage period. [Sudarsan *et al.,* (2017](#_ENREF_109)) described that there was no growth of fungal count during one month of storage period. From these findings it is concluded that the very low count was observed in beverage mix during storage period which was found to be within the acceptable limit only.

 The yeast count enumerated in beverage mix during storage period at regular interval. In this there was no count was observed upto 2 months of storage period. In 3rd month of storage period very few counts was observed in P1 packed beverage mix that is 1.0×10-1 cfu/ ml whereas, no growth showed in P2, P3 and P4 during storage. [Arokiamary *et al.,* (2020](#_ENREF_9)) reported that in 2nd month of storage period the yeast count of supplementary food mix had 4.0 to 6.0 x 104 cfu / g. [Sudarsan *et al.,* (2017](#_ENREF_109)) stated that there was no growth of yeast observed in instant mix during one month of storage period. [Khan *et al.,* (2014](#_ENREF_51)) noted that less than 100 colonies of yeast observed in instant porridge mix during 120 days of storage period.

## Conclusion:

 The finger millet based functional beverage mix which packed in PET bottle shows minimum changes in physico-chemical, microbial and sensory attributes than the sample packed in other packaging materials Low density polyethylene, standup pouch and aluminium foil pouches. A very low reduction rate of protein, fat, dietary fiber and ash were observed during storage. The samples stored in PET bottle also show minimum changes in the sensory attributes of the functional beverage mix when compared to other packaging material.

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