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Studies on processing and value addition of banana (Var. *Patakapura, Musa* Spp) by fortification of vitamin-E(α-Tocopherol)

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Abstract
Patakapura, a landrace of Rasthali (Amrithpani) group of banana, mostly grown in the coastal tracts of Odisha, admired by one and all for its pleasant aroma. However, availability of this variety of banana is limited and has a very poor nutritional percentage regarding to vitamin-E(α-tocopherol). In the present study, an effort has been made to fortify the pulp with vitamin-E(α-tocopherol) so as to enrich the food value of the product as it is very deficient in vitamin-E (α-tocopherol) content. Banana pulp was prepared from the marketable ripe fruits of *patakapura* variety and stored as 100 g sample in glass containers using three different concentrations of vitamin-E (α-tocopherol),i.e; 2mg, 2.5mg and 3mg per 100gm of finished product, referring to the recommended daily allowance (RDA) level of vitamin E(α-tocopherol) assuming >2 serve a day. The α-tocopherol content of fresh banana pulp was 0.1mg/100g, and after supplementation, the vitamin E contents of the samples increased significantly. However, the three different treatments remained statistically at par. Texture of the banana pulp within treatments and without any treatment showed non-significant ($p<0.05$) changes. This result was also supported from the microbial analysis of the samples which showed a slight increase of bacterial load from 13-27 CFU X 10^5. From the sensory test it was inferred that the processed banana pulp fortified with vitamin E @ 2mg/100g of pulp has been adjudged as the best and could be used more than two serve per day. The present study revealed that value addition of banana with supplementation of vitamin-E (α-tocopherol) may increase the nutritive value of banana in respect to vitamin contents.

Keywords: Banana pulp, *patakapoora* banana, vitamin-E fortification etc.

Introduction
Bananas are much appreciated and identified as rich source of carbohydrate and energy. Fruits also contain crude fibre, protein, fat, ash, phosphorus, iron, calcium, β-carotene, riboflavin, niacin, ascorbic acid and tocopherols (Mohapatra *et al.* 2010) [12]. Among the varieties of banana grown in the state the cultivar patakapura is well admired for its typical flavor and aroma. Vitamin E refers to a group of compounds that include both tocopherols and tocotrienols. Of the many different forms of vitamin E, γ-tocopherol is the most common form found in the North American diet. γ-Tocopherol can be found in corn oil, soybean oil, margarine, and dressings. Alpha tocopherol, the most biologically active form of vitamin E, is the second-most common form of vitamin E in the diet. This variant can be found most abundantly in wheat germ oil, sunflower, and safflower oils. This study was conducted because the ripe banana fruit contains very minute quantity of vitamin-E (α-tocopherol) and as a fat-soluble antioxidant, it stops the production of reactive oxygen species formed when fat undergoes oxidation.

The increasing presence and consumption of vitamin-fortified foods may even change the relative importance of several foods as the major contributors of certain nutrients (i.e. vitamin E) in the general population and, especially, in groups at-risk for not meeting reference intakes, such as children, adolescents, the elderly and people with certain diseases (Berner *et al.* 2001; Majem *et al.* 2001) [2, 10]. In developed countries, food fortification has proven to be an effective and low-cost way to increase the micronutrient supply and reduce the consequences of micronutrient deficiencies (Berner *et al.* 2001) [2]. This fact, along with other socioeconomic factors, has encouraged industries to improve the perceived value of their products through fortification. However we should first know the sensory analysis and role of vitamin-E in human body. Therefore in this study an effort has been made to fortify the ripe banana pulp with vitamin-E so as to enrich the food value of the product which may fulfil the

requirement of tocopherol in human beings with their regularly diet without taking any other supplement of vitamin-E.

Materials and Methods

Fruit materials: Studies on Processing and Value Addition of Banana *(Var. Patakapura, Musa Spp)* by Fortification of Vitamin-E (α-Tocopherol) was carried out at research laboratory of Department of Fruit Science and Horticultural Technology, College of Agriculture with active support of Department of Agricultural Processing and Food Engineering, CAET and Department of Microbiology, CPGS, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, during 2015-16. The design of the experiment was completely randomised design (CRD) with four treatments and four replications. Fruits of uniform colour, size and shape were selected. Diseased and damaged ones were discarded. Fruits were washed in clean tap water and hand peeled. The ripe fingers were chopped into small pieces in sterilized container for pulping.

Processing and supplementation of vitamin-E (alpha tocopherol): Natural alpha tocopherol capsules were collected from online market which was named as "iOTH HEALTHY GLOW". These capsules contain 400 IU d-alpha tocopherol, which was then taken to food processing lab for extraction of active ingredient (alpha tocopherol). For supplementation of vitamin E (alpha tocopherol), it was extracted from those capsules and a stock solution with ripe banana pulp was made. Thereafter, the three different concentrations of vitamin E (2mg, 2.5mg and 3mg w/w) was taken from the stock solution and supplemented to the ripe banana pulp and quickly these were filled in sterilized airtight glass containers of 100ml each and stored under low temperature (9±10C) in refrigerator for studying the quality standards and microbial load of the product.

Sensory evaluation: One hundred panelists (male=65, female=35) belonging to the age group of 24-40 years evaluated the sensory quality of the processed and preserved banana (patakapura) pulp supplemented with vitamin-E (alpha tocopherol). The panel consisted of some chosen faculty members and students of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. The panelists who usually consume processed pulp and other processed products (more than 4-5 servings a month) and willing to participate in the study were selected for the evaluation. Two sensory evolution sessions comprising 50 consumers for each session were conducted during April, 2016. Prior to evaluation, an introductory session was held to familiarize panelists with the product. After introductory session, the panelists were served with four samples of processed banana pulp with supplementation of vitamin-E in plastic plates, which had been labeled with a four – digit random number. Panelists were instructed to expectorate and rinse with water prior to evaluation. Time delay between judgments of two consecutive samples was fixed at 30 seconds to avoid respondent's fatigue. Samples were served to different order to each panelist (MacFie *et al*. 1989) [9]. Participants were also provided with a cup of water to cleanse their plates between each sample. Each consumer evaluated the samples for their sensory attributes (Meilgaard *et al*. 2007) [11]. The sensory attributes were quantified using a 5-point hedonic scale (1=dislike extremely, 2.5=neither like nor dislike, 5=like extremely). Consumers also indicated their acceptability on a nominal scale (1=acceptable and 0=not acceptable).

Estimation of vitamin-E (alpha tocopherol): For estimation of vitamin-E content in the pulp, the samples were submitted to the Animal Nutrition department of OVC, OUAT. The result of the processed and treated pulp samples were depicted in Table No.1 in the section of Results.

Microbial Analysis: The presence of microorganisms in any processed food is obvious until and unless they are treated with some sorts of sterilization mechanisms. The shelf life and quality of any processed food mostly depends on the microbial load and types of microbes. Thus, looking into these aspects, the microbiological analysis of the pulp for detection of the presence of aerobic heterotrophic bacteria was done by following the tenfold serial dilution and spread plate technique. Ten grams of processed banana pulp was diluted into 100 ml of sterile NSS (0.85% of NaCl) solution. The sample was further diluted up to 105 dilutions. 100 µL of the diluted sample was spreaded over sterile Plate Count Agar and Rose Bengal agar plate with the help of a L- shaped spreader for the growth of the bacteria and fungi respectively. The processed plates were incubated at 300 C±2 for 24 to 48 hours. The colony forming units per gram of the pulp were calculated as per the formula given below.

$$\text{CFU/gm of pulp} = \frac{\text{Mean plate count}}{\text{Quantity taken x dilution factor}}$$

Statistical analysis of data: The data recorded on various vitamin-E estimation and microbial characteristics of banana pulp as influenced by varying concentration of fortified vitamin E (alpha tocopherol) were subjected to Fisher's method of analysis of variance and interpretation of data were taken up as per Sukhatme and Amble (1995). The level of significance used in 'F' test was p = 0.05. Least significant difference or C.D.

Results and Discussion

The data relating to vitamin E (alpha tocopherol) content of banana pulp as influenced by varying concentration of fortified vitamin E (alpha tocopherol) at 48 hours after storage are presented in Table.1. The data showed that, the vitamin E (alpha tocopherol) content of banana pulp was significantly influenced by varying concentration of vitamin E (alpha tocopherol) fortified at 24 hours after storage. The maximum value was observed in treatment T3 (2.97mg/100g) and minimum value was observed in the control T4 (0.1mg/100g). The vitamin E (alpha tocopherol) content of fortified banana pulp remained static even after 48 hours of storage. This shows that there was no effect of fortified vitamin-E on the physico-chemical properties of the product. With regards to the processed pulp with varying concentrations of vitamin-E, the bacterial load was graphically represented in the Fig. No.1. The trend analysis of the bacterial population during storage study clearly indicates a vast increasing trend in the control sample from 12 CFU/g to 114 CFU/g. within the period from 0-48 hours of storage time. The treated pulp with different concentration of vitamin-E (2mg, 2.5mg and 3mg per 100g w/w) was showing a slight increasing trend of the bacterial population during the storage time of 0-48 hours.

However, the supplementation of vitamin further doesn't give any significant change to the bacterial flora among the

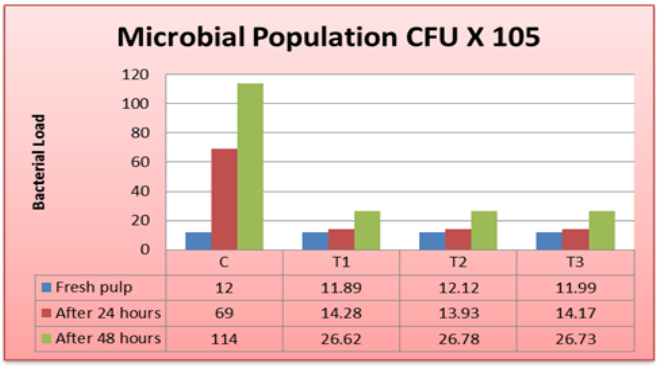
treatments in the pulp sample. With respect to the fungal population in the pulp it was observed that no fungal colony was growing in the RBA plates even after 72 hours of incubation. This analysis of microbial load are in line with Xu *et al*. (2016) [14]. The vitamin E (alpha tocopherol) is a fat soluble vitamin and present in very minute quantity in banana pulp. In the present investigation fortification of the banana pulp with vitamin E (alpha tocopherol) was made by introducing three different levels of vitamin E and after supplementation it was found increased to the supplemented quantity in the product and after further storage periods it was found that no changes happened to the quantity of vitamin E in the product.

Since, vitamin E is a fat soluble vitamin and the final product was water soluble, therefore may be no interaction occurred and hence, no changes might have been seen to the physico-chemical properties of the finished product. Vitamin-E (alpha tocopherol) may be used normally as a supplement but by introducing vitamin E (alpha tocopherol) in banana pulp, makes it more nutritious and value added. However, it is better to take it as a fortified product as we may complete the necessity of vitamin-E in our regularly diet by the final product of the aforesaid study without any hesitation of taking supplement. Over dose of vitamin E is toxic to human health, so, according to recommended dietary allowances(RDA), less than minimum dose of vitamin E (<4mg) was supplemented in the product, suggested by, vitamin-E health professional fact sheet, National Institute of Health (office of dietary supplements, US department of health and human services). However, this research was conducted to see the compatibility of vitamin-E in the fruit product and it has worked quiet fairly. The results obtained in the present investigation are in line with Barbudo *et al*. (2004) [1], Engelberger *et al*. (2003) [4] and Leskauskaite *et al*. (2016) [8].

Organoleptic Evolution: The organoleptic evaluation of final product was done and the data are expressed in terms of scores on a 5 point hedonic scale and are presented in Fig. No. 2. The results indicated that the treatments differed significantly with respect to all the sensory parameters. Significantly highest score for taste was observed in T1 (4.23) followed by T2 (3.89). The treatments T3 and T4 recorded significantly lowest score 2.05 and 1 respectively for taste. Significantly highest score for flavour was observed for T1 (4.75) followed by T2 and T3 (2.47), whereas the lowest score was recorded in T4 (1). The treatment T1 (4.61) recorded significantly highest score for overall acceptability, whereas lowest was recorded in T4 (1.0).

Table 1: Vitamin E (alpha tocopherol) content (mg/100g) of ripe banana pulp as influenced by varying storage periods.

Treatments	Fresh pulp	After 24 hours storage	After 48 hours storage
T1 (2mg vit-E)	0.1	1.98 ± 0.01	1.98 ± 0.01
T2 (2.5mg vit-E)	0.1	2.44 ± 0.03	2.44 ± 0.03
T3 (3mg vit-E)	0.1	2.97 ± 0.04	2.97 ± 0.04
T4 (control)	0.1	0.10 ± 0.004	0.10 ± 0.004
CD @ 5%	-	0.04	0.04
SE (m) ±	-	0.01	0.01
CV %	-	1.60	1.60



Note: C-control, T1-2mg vit-E, T2-2.5mg vit-E and T3-3mg vit-E**.**

Fig 1: Microbial Analysis at CFU X 10^5 with varying Vitamin-E levels for different storage periods

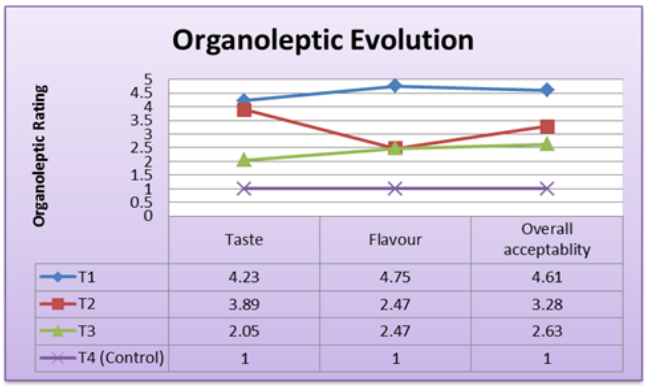


Fig 2: Depiction of sensory evolution

Conclusion

From the study it could be inferred that the physico-chemical properties of banana (var. patakapura) should not get disturbed by the fortification of vitamin-E and requirement of vitamin-E may be fulfilled by just only the regularly diet without any exception of taking it normally as a supplement. Hence by this fortification we can increase the value of the product by nutritional enrichment of vitamin-E by adding alpha tocopherol @ 2mg/100g of pulp. However, this is a new line of work which has got plenty of Research Avenue in future, because fortification of vitamin-E is novel study to the food and fruit products.

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