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An emerging segment of fortification technology- evaluation of Micronutritional status of fortified beverage

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Abstract
This research was undertaken to evaluate the micronutritional composition of developed fortified beverage as an emerging segment of fortification technology. Since, milk is a good medium for fortification of nutrients especially micronutrients. The fortificants from natural sources such as fruits and vegetables were incorporated into skim milk with suitable levels. The levels of fortificants were carrot juice (15%), moringa leaves juice (5%), irradiated mushroom juice (6%), date juice (2%) and seaweed (1%). The fortified beverage was analyzed for micronutritional composition by utilizing the analytical instrumentations. The result was revealed that, there was a highly significant difference between the developed fortified beverage and unfortified beverage (control). Thus, it was found that the developed fortified beverage will be addressing the challenges of hidden hunger or malnutrition.

Keywords: Emerging technology, fortification, micronutrients, natural source, functional beverage

1. Introduction
Now a day people are very aware of consuming the safe and nutritious foods than the tasty foods. They want to consume the food which fulfills all their nutritional requirements and are from natural origin. Due to the increase in demands for natural and organic products, fruit juice and other fruit-based beverages have a great scope in these recent days. Since, India is the No.1 milk producer (198.4 million tonnes) and second largest producer of fruits and vegetables (132.03 million metric tonnes) all over country; On the other hand many fruits and vegetables are not fully utilized as because of lacking in processing techniques and instrumentations and so milk based fruits and vegetables fortified beverage was developed to meet out the consumer need through the emerging technology.

Carrots are good source of beta carotene. Beta carotene is precursor of vitamin A which is regarded as important for combating vitamin A deficiency (VAD) (Fratianni *et al*. 2010) [5]. Carrot juice is rich in functional food components such as vitamins (A, D, B, E, C, and K) and minerals, (calcium, potassium, phosphorus, sodium, and iron). It has been noted that 100 g of carrot contains between 6 mg and 15 mg of carotenoids, mainly β-carotene (2-10 mg). Analysis of Moringa juice has revealed that the level of provitamin A in carrot made a positive impact on the moringa juice by increasing the total amount of the provitamin A to 6.64 g/100 g (Otu *et al*., 2013) [9]. Date consumption is an important source of supplying vitamin and mineral in a balanced nutrition regime (Al- Shahib and Marshall, 2003) [2]. Chemical composition showed that the flesh of dates has good nutritional value, based on its dietary fibers, minerals, vitamins, natural antioxidants, and other bioactive compounds (Elleuch *et al*., 2008) [4].

The iodine deficiencies can be controlled using sole fortification of iodine source such as in table salt or it can be fortified as multiple micronutrient fortifications of beverages. Seaweeds were the primary source of iodine for medicinal purposes, only being supplanted by the discovery that iodine could be extracted used as an iodine source. Recently, in the United States, seaweeds have also been taken as food for natural source of iodine and other minerals in health supplements. Kappaphycus. sp is highly valued in dairy applications, meat products and in pet foods.

In keeping with the consumer's demand for food in all the aspects, milk based fortified functional beverage was developed with natural sources.

Moreover, People in the developing countries like India, they could not afford to diversify their diet with adequate amounts of fruits, vegetables and animal sources of food containing micronutrients hence deficiencies are inevitable also micronutrient deficiencies are unnoticed within the community. For these reasons, fortification is a powerful and cost effective approach to curbs the micronutrient deficiencies. Moreover, the advantages of using beverages as a fortification vector are due to higher consumer acceptance and flexible delivery as ready to consume beverage products (Aaron *et al*., 2015) [1].

2. Materials and Methods

2.1 Materials

Skim milk, carrots, moringa leaves, mushrooms, dates and sugar were the main ingredients in the developed fortified beverage. No chemicals or synthetic preservatives were used in the study. The glasswares and instruments utilized were completely sterilized before and after the processes. Figure.1. shows the flowchart for the development of fortified functional beverage.

2.2 Methodology

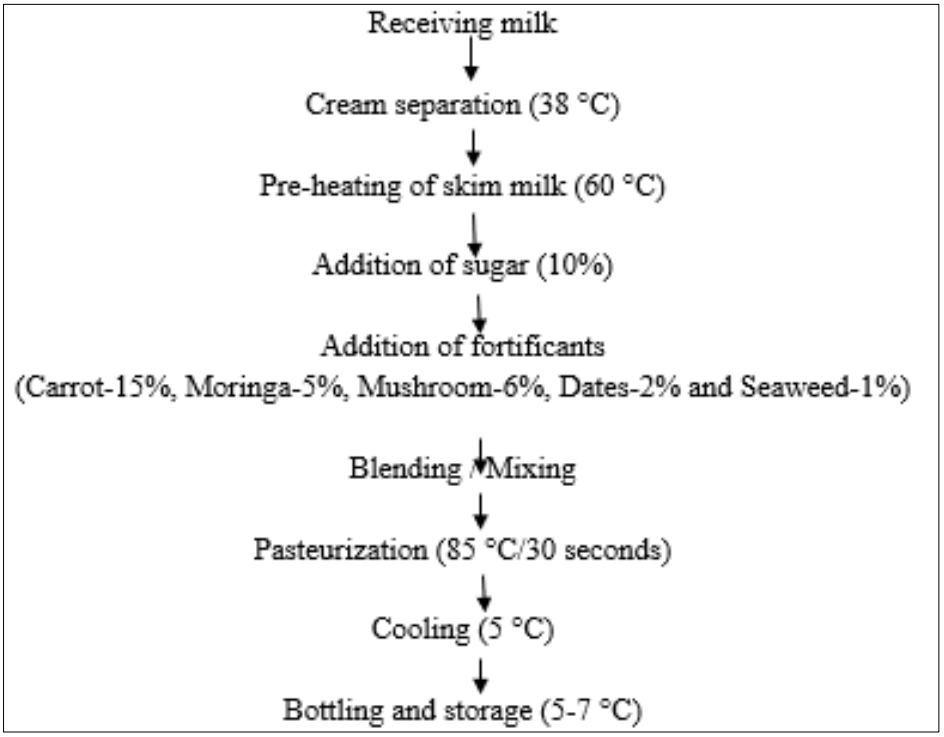

Fig 1: Development of Fortified Functional Beverage

Fortified Beverage

Unfortified Beverage

2.3 Estimation of micro-nutrients in the developed beverage

Vitamins such as vitamin A and vitamin D were estimated by using High Performance Liquid Chromatography and minerals such as iron, calcium, magnesium, zinc and iodine (IS 7224:2006 RA 2010) were analyzed by using Inductively Coupled Plasma – Optical Emission Spectrometric method.

2.4 Statistical Analysis

Statistical analysis was carried out to study the effect of fortification and the status of nutritional composition in the developed fortified beverage. The data were tabulated and subjected to statistical analysis performed using IBM SPSS® 20.0 for Windows® software as per the standard procedure of Snedecor and Cochran, (1994). Analysis of variance (ANOVA) was conducted to determine whether significant effect exists on micro-nutritional values of control/unfortified and fortified beverages.

3. Results

3.1 Estimation of vitamin A and vitamin D

Table.1 showed the vitamins (vitamin A and vitamin D) concentration of control and fortified beverage. Statistical analysis showed that a highly significant difference ($P< 0.01$) was found in the control and fortified beverage with regard to vitamin A and vitamin D. The average values (Mean±SE) of vitamin A for control and fortified beverage were 0.028±0.001 and 0.092±0.002 while the average values (Mean±SE) of vitamin D for control and fortified beverage were 0.0014±0.000 and 0.0162±0.000 respectively.

Table 1: Estimtion of Vitamin A and D (Mean±SE)@

Vitamins	Treatments		T-Value
	Control	Treated	
Vitamin A (mg/100g)	0.028±.001	0.092±.002	35.157**
Vitamin D (mg/100g)	0.0014±.000	0.0162±.000	42.375**

@-Average of six trials; **- Highly Significant ($P< 0.01$)

3.2 Estimation of mineral contents

Table.2 represented the mineral contents of control and fortified beverage. Statistical analysis showed that a highly significant difference ($P< 0.01$) was found in the control and fortified beverage with regard to minerals such as iron, calcium, magnesium, zinc and iodine. The average values (Mean±SE) of minerals such as iron, calcium, magnesium and iodine for control were 0.00±0.00, 100.22±0.323, 7.10±0.106, 0.11±0.009 and 0.03±0.001 fortified beverage were 15.00±0.00, 150.0±0.577, 20.33±0.422, 4.00±0.153 and 0.52±0.254 respectively.

Table 2: Estimation of mineral contents (Mean±SE)[@]

Minerals	Treatments		T-Value
	Control	Fortified	
Iron (mg/100g)	0.00±0.00	15.00±0.00	0.000**
Calcium (mg/100g)	100.22±0.323	150.0±0.577	75.256**
Magnesium (mg/100g)	7.10±0.106	20.33±0.422	30.431**
Zinc (mg/100g)	0.11±0.009	4.00±0.153	25.406**
Iodine (mg/100g)	0.03±0.001	0.52±0.254	19.462**

@-Average of six trials; **- Highly Significant ($P< 0.01$)

4. Discussion

- In this current research, the highly significant difference were observed between the unfortified beverage and fortified beverage and the concentration of fortified micronutrients in the developed beverage were not less than the recommended daily intake level. The values were observed to be within WHO (2006) tolerable upper intake value.
- Beta-carotene that is pro-vitamin A is more stable than the alpha-carotene during food processing, the same results were found by Baloch, 1977. Vitamin D3 is relatively more stable than vitamin D2, possibly because it has one fewer double bond, on par with Skibsted, 2010 [10]
- The minerals such as iron, calcium, magnesium, zinc and iodine present in the developed beverage was the good supplement as per the ICMR, 2009 recommended dosage level.

5. Conclusion

This research found that, effective utilization of natural sources could be possible through the fortification technology. The emerging fortification technology definitely would have the impact on health of consumers. The fortification of beverages with vitamins and minerals, like addition of micronutrients into milk based beverage had positive results from this research. The composition of micro-nutrients (vitamins and minerals) of developed fortified beverage obviously has higher values than the unfortified beverage. Hence the fortification of micronutrients would definitely meet out the consumer's demands on their health oriented supplements.

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