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Fortification of *lassi* with vitamin a using natural vegetable powders

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Abstract
Vitamin A deficiency control is a realizable goal required to address through combination of interventions. Among these, fortification of commonly eatable foods has great potential to help realize this goal. However, such foods must be consumed with a narrow range of intakes: so that it harness valuable benefits over vitamin A deficiency in most people, but does not cause toxicity in people who eat more than average amounts. The dairy products in original form are not pretty good source of vitamin A and thus fortification of vitamin A to dairy products can provide a nutritious food. The present study utilized the natural reservoir of Vitamin A vegetable powders for inclusion in *lassi* so as to prepare a healthy dairy beverage. Different concentrations of above mentioned powders were utilized and sensorily best acceptable values were used for further physico-chemical analysis.

Keywords: Fortification of *lassi*, vitamin, natural vegetable powders

1. Introduction
With a huge population of over and above 1.32 billion people which is almost equivalent to 17.74 % of world total population, major chunk of Indian population is suffering from either micro or macro nutrient deficiency. Various macro nutrient deficiency programmes are being taken by the government at large scale whereas the people suffering from micro nutrient deficiency diseases require immediate attention from academician and policy makers point of view. Amongst these deficiency issues, vitamin A deficiency occupies a prominent role not only in rural population but also among urban population. Fortifying the food products with natural sources of vitamin A will decrease the graph of vitamin A deficiency of course therefore, fortification of food with micro nutrients is a viable technology for diminishing micro-nutrient malnutrition as part of a food-based approach, where existing food supplies and limited access fails to provide adequate levels of the respective nutrients in the diet. The World Health Organization (WHO) estimates that 190 million pre-school children are deficient in one of the major micro-nutrients, vitamin A (Paul *et al.*, 2016) [1]. Nearly, 44-50% preschool children in South Asian regions were affected by severe VAD and 85% of these children with xerophthalmia reside in India (Agrawal and Shrivasta, 2015) [2]. Vitamin A deficiency is not only problem to pre-school aged children, it is also a problem in pregnant and lactating women and sometimes school aged children and adolescent in developing countries (Dary and Mora, 2002) [3]. VAD prevalence in children age 6–59 months in Uganda has increased from 20% in 2006 to 38% in 2011 and a similar increase was seen from 19% to 36% in women age 15– 49 years. The daily requirement of vitamin A for children under 60 months is 120 ug/day for females ranging from 235 µg/day up to 445 µg/day especially for lactating mothers (Paul *et al.*, 2016) [1]. Vitamin A plays an important function in the human body. Vitamin A is necessary for growth and bone development and to maintain eye sight and health of skin (Akram *et al.*, 2011) [4]. In developed countries, food fortification has proven to be an successful and cost effective method to enhance the micro-nutrient supply and to decrease the consequences of micro-nutrient deficiencies (Dary and Mora, 2002) [3].
Vitamin A fortification can be done in fermented dairy products as dairy products are good sources for fortification, not only due to worldwide consumption of dairy products, but also because of high nutritional value and advantage of buffering effect in digestion and absorption. As dairy products only provide about 6-9% of total vitamin A intake in Indian diet without any fortification, fortification of such kind of milk and milk-based products with natural sources of vitamin A will improve the nutritional status of such foods as functional foods (Chawla ad Sivakumar 2017) [5].

A fermented milk product has been defined by the international dairy federation, as the milk product prepared from skimmed milk or not with specific cultures. The microflora is kept alive until sale to the consumers and may not contain any pathogenic germs (Panesar, 2011) [6]. The role of fermented milk in human nutrition is well documented and these products have long been an important component of nutritional diet. The medicinal and nutritional properties of various fermented foods have also been experienced and well claimed by several generations. Furthermore, the nutritional value can be improved to more extent using natural sources of vitamin A, wherein carrot and sweet potato are the few examples which are neither costly nor unavailable to middle class income group. These are also good sources of various vitamins, minerals and fibers and does not contain protein and fat (Agarwal and Prasad, 2013) [7]. As fermented dairy products are good source of protein and fat. So, inclusion of carrot and sweet potato in dairy products can be used to prepare nutritious food.

Carrot is an inexpensive and highly nutritious vegetable. It is rich in Vitamin A, B_1, B_2, C, E, Folic acid, β- carotene, carbohydrate, calcium, phosphorous, iron, potassium, magnesium, copper, manganese and sulphur, besides having potent antioxidant property (Agarwal and Shrivasta, 2013) [7]. In carrots, β-carotene is present in a high concentration and it is one of the most essential micronutrients having antioxidant activity and its property to act as a provitamin A (Knockaert *et al.*, 2012) [8]. Bandyopadhyay *et al.*, 2008 [9] reported that 100g of carrot contains between 6 mg and 15 mg of carotenoids, mainly β-carotene. Along with carotenoids, vitamins and minerals, carrots are rich source of dietary fibre (Bao and Chang, 1994) [10]. Likewise, sweet potatoes are nutritious food and are good source of antioxidants (Teow *et al.*, 2007) [11], fiber, zinc, potassium, sodium, manganese, calcium, iron and vitamin C (Antia *et al.*, 2006) [12] but low in fat and protein. Sweet potato powder also contains coloured pigments like β-carotene, anthocyanin and flavonoids. These pigments acted as antioxidants and protect against oxidation, cancer, cataract, ageing and liver injury (Yamakawa, 1998) [13]. The β-carotene content ranges from 108.1 to 314.5 ug/g in sweet potato (Bengtsson *et al.*, 2008) [14].

2. Material and Methods

2.1 Preparation of Curd

The milk was obtained from Experimental Plant of College of Dairy Science and Technology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The fat content of obtained milk was standardized to 3.0% and SNF to 10%. For safe and hygienic milk, pasteurized milk was used for further curd preparation. Then for culturing the milk was cooled to 37^0 C and inoculated with NCDC culture 167 obtained from ICAR-NDRI, Karnal. The cultured milk was incubated at 37^0 C for 6 hours or until 0.6 to 0.8 % acidity was achieved.

2.2 Processing of Raw Material

Carrot powder and sweet potato powders were purchased from Calensa Agro Biotech, Pune. For incorporation in fermented dairy product, both the powders were used in extract form considering the coarse mouthfeel when used in direct addition form. Therefore, the extract was used for further fortification. For this, powder was immersed for half an hour in hot water and strained through muslin cloth.

2.3 Preparation of fermented dairy product-*lassi*

The curd and *lassi* were processed in the College of the Dairy Science and Technology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. For *lassi* preparation, 50 % curd weighed and churned with small quantity of water using hand blender (Philips 250W). To these, varied levels of extract of powders and 7% sugar was added, after dissolving in small quantity of water.

2.4 Physicochemical analysis

The moisture content, protein, ash, acidity and total soluble solids were determined according to AOAC method (AOAC, 2000) [15]. The protein content was estimated using kjehldal method and a conversion factor of 6.25 was used. The titratable acidity as % lactic acid was measured by titrating the *lassi* with 0.1 N NaOH and using phenolphthalein as indicator. The muffle furnace heated at 550^0C was used for ash determination. The hand refractrometer (Erma, Japan) was used for total soluble solids at 20^0 C. Fat content of flavoured *lassi* was estimated using Rose- Gottlieb method. The ethyl ether and petroleum ether was used for the extraction of fat from weighed sample as per standard method. The total sugars were estimated with Lane and Eynon method of BIS (BIS, 1981) [16]. The specific gravity of flavoured *lassi* was determined by taking weight and volume with the pyknometer maintained at 20^0 C. The viscosity of all prepared samples was measured with Brookfield Viscometer (LV DV2T) using LV- 0 1 (61) spindle at 5^0 C. Brookfield viscometers employ the principle of rotational viscometry i.e. the torque required to turn an object, such as a spindle, in a fluid indicates the viscosity of the fluid.

2.5 Sensory evaluation

Samples of *lassi* containing different levels of extracts of carrot and sweet potato powder were evaluated by 7 judges semi trained panel for attributes of color/appearance, mouthfeel, richness, sweetness, flavour and overall acceptability scores on a 9- point hedonic scale (Larmond, 1982) [17].

2.6 Statistical Analysis

The experimental data was analysed for analysis of variance (ANOVA) using CPCS software and expressed as values were average of three observations.

3 Results and Discussion

The varied levels of carrot and sweet potato powder were tried for preparation of *lassi*. The carrot and sweet potato powders were added @ 5, 7.5 and 10 % to check its acceptability sensorily (Table 1).

Table 1: Treatments of carrot powder and sweet potato powder

Treatment level (%)	Carrot powder	Sweet potato powder
Control	0.0	0.0
5.0	T1	P1
7.5	T2	P2
10	T3	P3

3.1 Effect of addition of carrot powder and sweet potato powder on physico-chemical properties of *lassi*

The data for addition of augmented levels of extracts of carrot and sweet potato powders in *lassi* showed significant ($p<0.05$) increase in various physico-chemical properties (Table 2). The control sample contained 12.79 percent total solids and inclusion of 7.5 percent carrot powder and 10 percent sweet potato increased the same to 16.5 and 13.88 per cent, respectively. This increase was due to high total solids in both extracts of powders. However, increase in sweet potato powder was found statically non-significant even at 7.5% [18]. Singh *et al*., 2005 reported similar kind of results with respect to increase in total solids while adding carrot juice from 10 percent to 30 percent in milk beverage. Similarly, [19] Collins *et al.,* 1991 also observed increase in total solids and decrease in moisture content with addition of sweet potato powder @ 14 to 16 percent. The total soluble solids of control sample were found 10.33^0 B which increased to 15.43^{0}B and 12.96^{0}B with addition of 10 per cent carrot & sweet potato powders, respectively. The TSS was observed more in carrot powder *lassi* as compared to sweet potato *lassi* due to more sweetness of carrot. In case of evaluating acidity, inclusion of carrot powder caused increase from 0.37 per cent to 0.62 per cent whereas it increased to 0.54 per cent with sweet potato powder. Results of acidity are in concurrent with studies undertaken by [7] Agarwal and Prasad, 2013, [20] Salwa *et al.,* 2004 and [18] Singh *et al.*, 2005 wherein increase in acidity was observed with the addition of pulps and juices like carrot.

Table 2: Effect of carrot and sweet potato powder on physico-chemical properties of *lassi*

Carrot powder (in per cent)	**Control**	**T1**	**T2**	**T3**
Total Solids, (%)	$12.79^a±0.74$	$14.48^{ab}±0.67$	$16.5^b±0.60$	18.1^{bc} ±0.2
TSS, (^{0}B)	$10.33^a±0.00$	$13.33^b±0.00$	$14.33^b±0.00$	15.43 $^{bc}±0.11$
Acidity, (% lactic acid)	$0.37^a±0.025$	$0.43^b±0.023$	$0.50^c±0.005$	0.62 ^{d} ±0.09
Specific Gravity	$1.03^a±0.005$	$1.039^a±0.013$	$1.044^a±0.010$	$1.049^a±0.001$
Viscosity, (cp)	$17.2^a±0.17$	$18.6^b±0.00$	$20.3^c±0.00$	21.23^{cd} ±0.95
Sweet potato powder, (in per cent)	**Control**	**P1**	**P2**	**P3**
Total Solids, (%)	$12.79^A±0.23$	$13.12^A±1.51$	$13.88^A±0.36$	$14.27^A±3.01$
TSS, (^{0}B)	$10.53^A±0.50$	$12.5^B±0.5$	$12.8^B±0.00$	$12.96^B±0.15$
Acidity, (% lactic acid)	$0.37^A±0.02$	$0.39^A±0.015$	$0.48^B±0.03$	$0.54^C±0.02$
Specific Gravity	$1.036^A±0.00$	$1.041^B±0.00$	$1.043^C±0.001$	$1.044^D±0.00$
Viscosity, (cp)	$17.2^A±0.17$	$17.5^B±0.05$	$18.4^C±0.00$	$19.2^D±0.00$

n=7, Values are Mean ± Standard Deviation,
Values in a,b and c are of carrot powder and in A, B, and D are of sweet potato powder with different superscripts differ significantly

Specific gravity of 7 per cent carrot powder and 10 per cent sweet potato *lassi* were quiet comparable wherein value increased from 1.036 for control to 1.044. Also, significant increase in values of sweet potato was observed for the respective attribute. The similar results were observed by [18] Singh *et al.*, 2005 for specific gravity, which increased with increasing levels of carrot juice. The viscosity of prepared samples increased significantly with increasing levels of both extracts of powders. However, significant increased viscosity was observed for carrot powder considering its high bulk of the powder, which is also reflected in the total solids of the powder. [21] Okoye and Animalu, 2009 reported the similar findings for many of above mentioned attributes wherein addition of sweet potato starch caused increase in acidity, TSS and viscosity of yoghurt *lassi.*

3.2 Effect of addition of carrot powder and sweet potato powder on sensory scores of *lassi*

The results obtained for sensory scores are presented in Table 3. For all attributes i.e. color, mouthfeel, richness, sweetness, flavour and overall acceptability, the scores differed non-significantly, which can due to minor perceivable differences in the subjective evaluation of the product. The colour value was highest in carrot powder lassi with maximum powder incorporated into it. It is simply because of colour contributed by the powder within the sample upon dissolution and liking of light red colour contributed by the powder. The colour values increased with increasing levels of powders among T1, T2, and T3 whereas in case of sweet potato *lassi*, the colour values decreased non-significantly with augmented levels of powder. It may be because of yellowness imparted by the powder which is one way is not in compatibility with the product like *lassi*. The mouthfeel and richness scores increased with increasing levels of both powders and highest scores was observed for T2 and P3 for both the attributes. The addition of 7.5 percent carrot powder resulted in highest scores for flavour than control and T1. Similarly, in sweet potato *lassi,* addition caused increase in flavour scores to P2 level and beyond that scores decreased due to disliking by the panellists. The highest overall acceptability scores were found in T2 and P2 samples of *lassi*. Similarly, [22] Mohapatra, 2007 reported that consumer panel preferred the curd samples containing 12 and 16 percent sweet potato puree for flavour, texture, colour and overall acceptability attributes. In products like beverage made from fortified juices value as high as 20 percent carrot juice fetched highest scores for appearance, body, flavour and overall acceptability scores (Singh *et al.,* 2005) [18], whereas Agarwal and Prasad, 2013 [7] reported 4 percent carrot pulp added yoghurt was the most acceptable.

Table 3: Effect of carrot and sweet potato powder on sensory scores of *lassi*

Carrot Powder, %	**Control**	**T1**	**T2**	**T3**
Colour	7.13±0.5	7.40±0.64	7.50±0.83	7.80±0.23
Mouthfeel	7.25±0.64	7.71±0.75	7.81±0.24	7.95±0.1
Richness	7.25±0.95	7.66±0.60	7.83±0.25	7.80±0.24
Sweetness	7.50±0.57	7.79±0.24	7.8±0.24	7.70±0.24
Flavour	7.50±0.57	7.53±0.45	7.54±0.32	7.50±0.42
Overall Acceptability	7.5±0.40	7.62±0.20	7.69±0.25	7.42±0.35
Sweet Potato Powder, %	**0**	**P1**	**P2**	**P3**
Colour	7.13±0.5	7.62±0.47	7.50±0.40	7.37±0.47
Mouthfeel	7.25±0.64	7.62±0.47	7.62±0.47	7.87±0.25
Richness	7.25±0.95	7.75±0.95	8.12±0.62	8.25±0.50

Sweetness	7.50±0.57	7.75±0.95	8.22±0.56	8.25±0.50
Flavour	7.50±0.57	7.62±0.47	7.87±0.85	7.37±0.47
Overall Acceptability	7.5±0.40	7.62±0.62	7.75±0.28	7.37±0.47

3.3 Quality attributes of selective treatments
From the above mentioned treatments, 7.5 per cent concentration for both the powders was found appropriate for incorporation in *lassi*. Therefore, the proximate composition of *lassi* with selective treatments has been presented in Table 4. The total solids of control sample was found 12.79 percent and it increased significantly to 16.58 percent and 15.68 percent with carrot powder and sweet potato powder respectively. The fat, protein, total sugars and ash content increased with inclusion of powders. Amongst all the tested parameters, only moisture and viz a viz total solid differed significantly.

Table 4: Quality attributes of selective treatments

Parameters	Control	Carrot powder (7.5%)	Sweet potato powder (7.5 %)
Moisture, %	$87.20^{a,A}$±0.23	83.42^{b}±2.23	82.47^{B}±0.60
Total solids, %	$12.79^{a,A}$±0.23	16.58^{b}±2.23	15.68^{B}±1.00
Fat, %	1.46±0.05	1.56±0.11	1.70±0.10
Protein, %	1.74±0.085	1.83±0.087	1.84±0.58
Ash, %	0.286±0.09	0.306±0.04	0.389±0.009
Total sugars, %	11.69±0.62	12.07±0.83	12.63±0.47

n=3, Values are Mean ± Standard Deviation, Values in a,b and c are of carrot powder and in A, B, and D are of sweet potato powder with different superscripts differ significantly

4. Conclusion
The carrot powder and sweet potato powder incorporated *lassi* was found acceptable at 7.5 per cent (both). The inclusion of both the powders caused significant increase in total solids, total soluble solids, acidity, specific gravity and viscosity. The percent moisture and total solids of selective *lassi* was also found significantly different when compared with control sample. The fortification of *lassi* with natural sources of vitamin A added in the form of vegetable powders can produce a well nutritious fermented dairy product.

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