The Pharma Innovation Journal 2023; 12(3): 1230-1233

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 1230-1233

www.thepharmajournal.com
Received: 01-12-2022
Accepted: 06-01-2023

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Sensory evaluation of zinc microcapsule incorporated milk products

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Abstract
Microencapsulation is a process in which active substances are coated in extremely small capsules to mask their undesirable organoleptic characteristics. By using the microencapsulation technique, the present study evaluated the sensory properties of milk products prepared with fortified milk, zinc salt, and zinc microcapsules. Zinc microcapsules were prepared by the spray-dying method using gum arabica and soy protein isolate as wall materials and zinc picolinate as core material. Zinc salt and zinc microcapsules were added @ 20 ppm to milk. Milk products made from fortified milk were tested for sensory properties using the BIS score card. There was no significant difference between the control, salt-fortified, and microcapsule-fortified flavouring milk, curd, and paneer. From the study, it can be concluded that zinc microcapsules can be used effectively for the development of milk products without affecting their sensory properties. Thus, zinc microcapsule-fortified milk products can be substituted for unfortified milk products to alleviate zinc deficiency among all age groups.

Keywords: Microencapsulation, sensory evaluation, zinc, milk

1. Introduction
Micronutrient deficiencies, also known as "hidden hunger," Around the world, "hidden hunger" affects two out of every three women of reproductive age and every other pre-schooler (Deol *et al.*, 2022) [5]. Over 80% of adolescents in India experience "hidden hunger," a form of undernutrition, according to a new press release from UNICEF (2019) [11]. In human bodies, zinc is found in smaller amounts than iron. More than 300 metalloenzymes and more than 2000 transcription factors involved in lipid, protein, and nucleic acid metabolism as well as gene transcription involve zinc.
Supplementation and dietary ingredient fortification are the methods being examined to address the issue of zinc deficiency in a broader population (Akhtar, 2013) [2]. Although supplementation is one of the most successful methods for reducing micronutrient deficiencies, it has some drawbacks, including the inability to reach a larger population, the dangers of taking too much, and the difficulty of reaching the poor. Therefore, there was no longer any dispute that food fortification was a successful strategy for raising the population's micronutrient status. Food fortification typically produces more long-lasting benefits than immediate results.
According to Akhtar (2013) [2], the choice of food vehicle used largely by society's most vulnerable groups determines the effectiveness of micronutrient enrichment treatments. The availability of milk in India during 2017–18 was 375 g per day per person, and the majority of the population, particularly children, consumes milk and milk products (Anonymous, 2019) [3]. Hence, milk products were selected as an ideal vehicle for fortification.
Directly adding zinc to milk causes organoleptic issues such as colour, odour, and taste, as well as a reaction with milk components and lower bioavailability (Gaucheron, 2000) [6]. So the microencapsulation technique was used to release the contents under controlled conditions. Microencapsulation is a process in which active substances are coated in extremely small capsules to mask their undesirable organoleptic characteristics. The success of this technology is due to the correct choice of the wall material, the core release form, and the encapsulation method (Silva *et al.*, 2014) [9].
Sensory acceptance of products after fortification plays an important role in the acceptability and sustainability of the product in the market. Therefore, in the present study, milk products were evaluated for sensory properties after fortification with zinc microcapsules.

2. Material and methods

Zinc microcapsules were prepared by the spray-dying method using gum arabica and soy protein isolate as wall materials and zinc picolinate as core material.

2.1 Fortification of milk

Milk was procured from the MARS dairy farm, University of Agricultural Sciences, Dharwad. Zinc salt and zinc microcapsules were added @ 20 ppm to milk. Milk products were made from fortified milk and tested for sensory properties.

2.2 Evaluate the suitability of zinc microcapsules fortified milk for milk product preparations

2.2.1 Flavoured milk

For flavoured milk preparation milk sample was mixed with sugar, heated at 63 ºC for 30 min/ HTST 72 ºC for 15 sec followed by cooling to 10 ºC and flavor was added, followed by packing and storing at 4±1 ºC. The developed product was subjected to sensory evaluation and compared with the flavoured milk made from unfortified milk.

2.2.2 Curd

For curd preparation, milk was heated intensively to boiling for 5–10 minutes, and then it was cooled to a temperature of 43 °C. The previous day's curd was added and allowed to set undisturbed, usually overnight. The developed product was subjected to sensory evaluation and compared with the curd made from unfortified milk.

2.2.3 Paneer

For paneer preparation, the selected milk was heated at 82 ºC for 5 minutes and cooled to 70 ºC It was then coagulated with citric acid (1% solution), which was added slowly to the milk with continuous stirring until curd and clear whey were separated. The mixture was allowed to settle for 10 minutes, and the whey was drained out through a muslin cloth. During this time, the whey temperature was kept above 63 degrees Celsius. The curd was placed in a wooden rectangular frame, and a weight of 45 kg was placed on it for 15-20 minutes. The pressed block of curd was then removed from the frame, cut into pieces, and immersed in chilled water (4-6 ºC) for 2-3 hours. After removing the chilled paneer pieces from the chilled water, they were placed outside for 10–15 minutes to drain the occluded water and remove the acid taste. The product was refrigerated and stored at 4±1 ^{0}C (Bhattacharya *et al*., 1971). The developed product was subjected to sensory evaluation and compared with paneer made from unfortified milk.

2.3 Sensory evaluation of milk products prepared from fortified milk

Prepared milk products were evaluated by the sensory panelists. A sensory panel of ten trained judges from the institute was asked to grade fortified milk products for changes in sensory characteristics. A composite scorecard for milk (used for flavoured milk and tea), curd, and paneer as approved by BIS (IS: 7768, 1975) [7] was used, with slight modifications. All sensory assessments took place at the University of Agriculture Sciences in Dharwad, Karnataka, India. Saline water (a 0.89 percent solution of sodium chloride) was provided as a palate cleanser for rinsing the mouth and cleaning the tongue before tasting each sample. Sensory scores were classified based on the BIS general scoring guide given in Table 1.

Table 1: BIS general scoring guide for Dairy Products

Sl. No.	Grade	Total score
1	Excellent (A)	90 and above
2	Good (B)	80-89
3	Fair (C)	60-79
4	Poor (D)	<59

3. Results and Discussion

Table 2: Sensory scores of flavoured milk prepared from zinc microcapsules fortified milk

Flavoured milk					
Fortified samples	**Flavour (Colour and appearance)**	**Odour**	**Taste**	**Mouthfeel**	**Total score (Over all acceptability)**
Maximum scores	**10**	**20**	**40**	**30**	**100**
Control	9.18±0.46^{a}	19.27±0.56 ^{a}	36.92±0.93^{a}	27.17±0.56^{a}	94.25±2.17^{a}
Salt fortified	8.57±0.45^{a}	17.56±0.97 ^{a}	34.0±1.22 ^{a}	25.32±1.29 ^{a}	86.48±3.54 ^{a}
Microcapsule fortified	8.47±0.46^{a}	18.92±0.74 ^{a}	33.17±1.71 ^{a}	25.73±1.35 ^{a}	85.92±3.29 ^{a}
CD	NS	NS	NS	3.74*	NS
SEM	0.44	0.79	1.33	1.24	3.05
F Value	0.20	1.26	2.25	6.23	2.67

3.1 Sensory analysis of flavoured milk

Flavoured milk was evaluated by a selected panel from the institute on the basis of the BIS composite sensory score card for milk. The sensory evaluation was based on the following important characteristics: flavour, odour, taste, mouth feel, and overall acceptability.

From the sensory scores of flavoured milk (Table 2), it was established that there was no significant difference (p>0.05) among control, salt, and microcapsule-fortified flavoured milk in all aspects of sensory analysis. For zinc microcapsule fortified flavoured milk, the colour and appearance score was 8.47 out of 10, the odour score was 18.92 out of 20, the taste score was 33.17 out of 40, the mouthfeel score was 25.73 out of 30, and the total score was 85.92 out of 100. According to the BIS general scoring guide for dairy products, this product is rated "good" (B). In terms of colour and appearance, odour, and taste, milk that has been supplemented with ferrous sulphate liposomes was non-significantly different from unfortified milk (Bhawana *et al.*, 2012) [4].

Table 3: Sensory scores of curd prepared from zinc microcapsules fortified milk

Curd						
Fortified Samples Maximum scores	**Flavour (Taste and aroma)**	**Body and texture**	**Acidity**	**Colour and appearance**	**Packaging**	**Total score (overall acceptability)**
	45	**30**	**10**	**10**	**5**	**100**
Control	43.17±1.28[a]	26.50±1.04[a]	8.57±0.59[a]	9.76±0.14 [a]	4.84±0.11[a]	92.83±2.72[a]
Salt fortified	38.75±1.77 [a]	25.25±1.04 [a]	8.09±0.52 [a]	9.07±0.28 [a]	4.93±0.08 [a]	85.08±2.57 [a]
Microcapsule fortified	37.33±1.16 [a]	25.75±0.84 [a]	8.68±0.48 [a]	9.53±0.25 [a]	4.91±0.08 [a]	88.17±2.11 [a]
CD	NS	NS	NS	NS	NS	NS
SEM	1.28	0.98	0.53	0.23	0.12	2.47
F Value	2.51	0.67	0.35	2.04	0.25	1.85

3.2 Sensory analysis of curd

Curd was evaluated by a selected panel from the institute on the basis of the BIS composite sensory score card for curd. The sensory evaluation was based on the following important characteristics: Flavour, body and texture, acidity, colour and appearance, packaging, and overall acceptability.

Curd sensory scores (Table 3) revealed that characteristics such as flavour, body, and texture; acidity; colour and appearance; packaging; and overall acceptability of the control, salt-fortified, and microcapsule-fortified curd were not significantly different (p>0.05) from each other For zinc microcapsule-fortified curd, the flavour score was 37.33 out of 45, the body and texture score was 25.75 out of 30, the acidity score was 8.68 out of 10, the colour and appearance score was 9.53 out of 10, Packaging score was 4.91 out of 5 and total score 88.17 out of 100. According to the BIS general scoring guide for dairy products, this product is rated "good" (B). Our results were in agreement with those of Abbasi and Azari (2011) [1], who fortified milk with liposomes and reported non-significant differences in terms of astringency, bitterness, and colour scores, and contrary results in smell and metallic taste. Shaikh *et al*., 2020 [8] gives the opposite results to our findings (sensory scores of control was higher than fortified one) that sensory evaluation indicated the superiority of zinc-fortified yogurt treatments, in particular compared to control yoghurt with a concentration of 100 milligrams, which obtained the highest scores.

Table 4: Sensory scores of paneer prepared from zinc microcapsules fortified milk

Paneer					
Fortified samples Maximum scores	**Flavour (Taste and aroma)**	**Body and texture**	**Colour and appearance**	**Packaging**	**Total score (overall acceptability)**
	50	**35**	**10**	**5**	**100**
Control	44.33±1.18[a]	33.84±0.53[a]	9.81±0.16[a]	5.0±0.0[a]	93.0±1.36 [a]
Salt fortified	42.25±1.87 [a]	32.66±0.83 [a]	9.24±0.32 [a]	5.0±0.0 [a]	87.17±2.58 [a]
Microcapsule fortified	42.58±1.68 [a]	32.66±0.53 [a]	9.16±0.31 [a]	5.0±0.0 [a]	88.42±1.86 [a]
CD	NS	NS	NS	NS	NS
SEM	1.61	0.64	0.26	0.05	2.00
F Value	1.68	1.07	1.76	1	2.37

3.3 Sensory analysis of paneer

Paneer was evaluated by a selected panel from the institute on the basis of the BIS composite sensory score card for paneer. The sensory evaluation was based on the following important characteristics: Flavour, body and texture, colour and appearance, packaging, and total score.

Paneer sensory scores (Table 3) revealed that characteristics such as flavour, body and texture, colour and appearance, packaging, and overall acceptability of the control, salt-fortified, and microcapsule-fortified paneer were not significantly different (p>0.05) from each other. For zinc microcapsule-fortified paneer, the flavour score was 42.58 out of 50, the body and texture score was 32.66 out of 35, the colour and appearance score was 9.16 out of 10, Packaging score was 5 out of 5 and total score 88.42 out of 100. According to the BIS general scoring guide for dairy products, this product is rated "good" (B). The results of present were in accordance with results reported by Tripathi *et al*., 2013 [10] products prepared from zinc fortified finger millet and sorghum flours were within acceptable range terms of texture (9), aroma (8.5), and taste (8).

4. Conclusion

From the study, it can be concluded that zinc microcapsules can be used effectively for the development of milk products without affecting their sensory properties. Thus, zinc microcapsule-fortified milk products can be substituted for unfortified milk products to alleviate zinc deficiency among all age groups.

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