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Physical, Functional and Microbiological Parameters of Tomato-Broccoli Blended Instant Vegetable Soup Mix

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The aim of the present study was to develop functional instant soup mix and to assess its physical and functional parameters during ambient storage conditions. For the development of instant soup mix, tomato and broccoli were blended in different proportions of 100:0, 95:05, 90:10, 85:15, 80:20, 75:25 and 70:30 and were packed in laminate pouches and stored for 90 days. Analysis for physical (Hunter colour value), functional parameters and microbiological parameters (total plate count) was conducted at a regular interval of 30 days. With the incorporation of broccoli powder mean L* value increased from 48.90 to 50.75, whereas mean a* and b* values showed a decreasing trend from 17.52 to 9.67 and 30.45 to 28.02, respectively. Among functional parameters, mean water solubility index decreased from 9.34 to 8.52 g/g and water absorption index decreased from 4.09 to 3.42 g/g. T_7 recorded highest bulk density (0.719 g/ml) and

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rehydration ratio (5.33). The overall acceptability was observed to be highest in T_4 (7.92). The microbial count was found within permissible limits during 90 days of storage.

Keywords: Tomato; broccoli; water absorption index; bulk density; overall acceptability.

1. INTRODUCTION

"Nutritional well being is an important force for health and development of people and expansion of human genetic potential. From the beginning of human history, food has been considered as the major factor in maintaining wellbeing and health of individuals" [1]. Nearly 200 countries grow vegetables, and in many regions of the world, they account for a sizeable amount of the human diet. Many vegetable commodities meet human calorie demands because of the carbohydrates they contain. A significant source of nutraceuticals for a well-balanced human diet are derived from vegetables. Therefore, incorporation of vegetables in food matrix increases their utility"[2].

"Tomato (*Solanum lycopersicum* L.) is highly edible crop around the world. Tomatoes can grow in areas with good soil fertility and moisture level. Tomatoes are an annual crop that are grown all year long and are a very good source of vitamin A, carbohydrates, and some protein, among other beneficial nutrients. A raw tomato contains 93.5 per cent water, 0.9 g of protein, 0.3 g of fiber and 0.2 g of fat per 100 g" [3]. "The average vitamin C content supplied by tomato is about 40 per cent of the adult USDA of 60 mg" [4]. "Tomatoes are the major dietary source of the antioxidant lycopene, which has been linked to many health benefits, including reduced risk of heart diseases and cancer. However, tomatoes are highly perishable in the fresh state leading to losses and wastage during peak season. Huge quantities of tomatoes are lost due to lack of proper processing, storage and transportation facilities. Accordingly, reducing these kinds of losses and wastage is crucial, particularly when there is subsequent imbalance in demand and supply in the off season" [5]. "Broccoli scientifically known as *Brassica oleracea* L. contains high levels of vitamins, antioxidants, and anti-carcinogenic compounds and has been described as a vegetable with high nutritional value. Broccoli is the richest sources of health promoting antioxidants, glucosinolates and essential nutrients like calcium (48 mg/100 g), total dietary fibre (3.0 g/100 g), selenium (3.0 µg/100 g), magnesium (25 mg/100 g), zinc (0.4 mg/100 g), folate (71 µg/100 g), ascorbic acid (93.2 mg/100 g) and β-carotene (779 µg/100 g)" [6]. This crop is a source of valuable nutrients like Vitamin A, C and riboflavin. Broccoli is consumed both as fresh and processed food and is regarded as a dual use vegetable.

"Soup is a very popular food item among the general population. The growing awareness of nutrition and the need for simpler, lighter meals are the main reasons soups are so popular today. However, most of the available instant soups are not up to the mark regarding nutritional quality. Incorporating plant-based sources of protein, minerals and vitamins that are appropriate for all ages could raise the nutritional quality. In the modern world commercially prepared instant soup (such as canned, dehydrated, and frozen soups) are replacing homemade soup as preparing soup at home is a time consuming process. Due to its ability to meet both current and foreseeable societal consumer demands, instant soups, a category of dried foods, are crucial to human nutrition" [7]. Considering these, tomato and broccoli would be a good choice of sources owing to their high nutritional quality. Therefore, the rationale of the study was to develop instant vegetable soup mix from tomato and broccoli blends and its physical, functional and microbiological analysis during storage.

2. MATERIALS AND METHODS

Ripe tomatoes were cleaned, washed and subjected to hot water blanching for 3-5 minutes and were then allowed to cool afterwards. The blanched tomatoes were cut into small slices (around 1cm). Then, the slices were dipped in 2 per cent sodium benzoate solution at room temperature for 5 minutes and were drained thoroughly after the dip treatment [8]. The tomato slices were then placed uniformly on stainless steel trays by spreading them as a single layer and were dried at 50°C for 16 hours in a tray drier. After obtaining constant moisture content, cooling was done at room temperature, the dried tomato slices were ground by using grinder and sieved to obtain fine tomato powder.

Broccoli was cleaned, washed under running tap water and surface water was dried. The florets

were then separated from the bottom and blanching was done at 80ºC for 3 minutes in 0.1 per cent solution of sodium bicarbonate [9]. The broccoli florets were then crushed so as to reduce time for drying and increase drying rate. Drying was carried out at 50ºC for 8 hours with constant air flow rate. After obtaining constant moisture content dried broccoli was ground and sieved to obtain fine broccoli powder. The dried tomato and broccoli powder were blended in varied ratios (100:00, 95:05, 90:10, 85:15, 80:20, 75:25, 70:30) and mixed with corn flour (20%), onion powder (8%), garlic powder (8%), salt (2%) and black pepper powder (2%) as per standard recipe to formulate seven different soup mixtures (three replications for each formula). The prepared tomato: broccoli blended instant vegetable soup mix powder were packed in laminate pouches, sealed and stored under ambient conditions (27±2°C) for a period of 90 days. Colour analysis of the sample was performed using HUNTER Lab Colorimeter (Hunter Lab Colour Flex Reston VA, USA) as per method of Vargas *et al*. [10].

Water solubility index was determined by taking one g of sample which was suspended in 10 ml of distilled water and centrifuged at 3500 rpm for 10 min. The liquid supernatant was poured into a tarred evaporating dish and dried at 110°C to constant weight. The amount of dried solids recovered by evaporating the supernatant and weight of dry solids were used in calculation of water solubility index was determined by Yousf *et al*. [11].

Water absorption index (WAI) of sample was calculated by the method described by Charunuch*et al*. [12] in which a weighed sample of 2.5 g was suspended in 50 ml tared centrifuge tubes containing 30 ml of distilled water. The sample was stirred intermittently over a period of 30 minutes and centrifuged at 3000 rpm for 10 min. The supernatant obtained was poured carefully into a tared evaporating dish and the remaining gel was weighed.

A method described by Amandikwa [13] was used for the determination of bulk density. The ground sample (10g) was taken in a pre-weighed 25 ml measuring cylinder. The bottom of cylinder was gently tapped on a pad till constant volume was observed. The volume occupied by sample was noted and bulk density was expressed as g per ml.

For bulk density estimation weighed sample of 10 g was soaked in a beaker containing 100 ml distilled water covered with watch glass. The contents were boiled for a few minutes. After that the water was drained and the soaked sample was air dried on filter paper and weighed again. The rehydration ratio was expressed as ratio of the weight of rehydrated product to the weight of dried product Ranganna, [14].

The overall acceptability of tomato-broccoli blended instant vegetable soup mix was evaluated by a panel of 10 semi-trained judges following the 9 point hedonic scale assigning (scores assigned as 9- “like extremely” to 1- “dislike extremely”) as described by Amerine *et al*. [15]. The mean score of 5.5 and above out of 9 were considered acceptable. For determination of microbial count spread plate technique using dilution method, described by Pelczar and Chan [16] was followed. The data obtained was analyzed statistically by Gomez and Gomez, [17] using Factorial completely randomized design (CRD) for interpretation of the results through analysis of variance.

3. RESULTS AND DISCUSSION

Colour is one of the important factor which determines the acceptability of food products. The colour values of tomato-broccoli blended instant vegetable soup mix were measured in terms of Hunter values L* (lightness), a* (redness/greenness) and b* (yellowness/blueness) (Table 1). Among the blends, L* value showed an increase of 3.70 per cent whereas, a decline of 44.80 and 7.78 per cent was observed in a* and b* values, respectively. With the increase in incorporation of broccoli powder the mean L* value followed an increasing trend which might due to higher L* value (Lightness) possessed by broccoli powder. a* and b* values decreased significantly with the increase in proportion of broccoli powder which might be due to less redness and yellowness in broccoli powder. The maximum mean value of L* was recorded as 50.75 in blend T_7 and the minimum mean value of 48.90 for T_1. The maximum mean value of a* was recorded in blend T_1 as 17.52 and the minimum mean value of 9.67 was recorded in blend T_7. The maximum mean b* value was recorded in blend T_1 as 30.45 and minimum mean value was recorded in blend T_7 as 28.02. After 90 days of storage, the mean colour values, L* and b* showed 2.86 and 3.5 per cent reduction, respectively, whereas a* value showed 7.17 per cent increase which might be due to oxidative and enzymatic reactions. The decrease in colour values during storage might

be due to the degradation of colour pigments and formation of brown pigments (melanoidins) by Maillard reaction [18].

The mean water solubility index of soup mix among blends showed a decline of 8.70 per cent (Fig.1a) in blend T_7. Decrease of 2.65 per cent in water solubility index was recorded during 90 days of storage which might be due to hygroscopic nature of the dried mix. The highest mean water solubility index of soup mix was found in blend T_1 as 9.34 g per g and the lowest in blend T_7 as 8.52 g per g. Among blends decrease of 16.38 per cent was recorded in water absorption index of soup mix (Fig. 1b). The highest mean water absorption index of soup mix was found in blend T_1 as 4.09 g per g and lowest in blend T_7 as 3.42 g per g. With the increase in concentration of broccoli powder, the water absorption index decreased which might be due to the high water absorption index of tomato powder. The decrease might also be due to the fact that broccoli (carrier agent) when added in tomato reduced the particle-particle cohesion resulting in less agglomeration, and therefore, decreased the water holding capacity of powders [19].The mean value of water absorption index showed an increase of 6.31 per cent during 90 days of storage which might be due to increase in soluble compounds of the powder [20].

Bulk density of blend T_7 was 33.39 per cent higher than that in T_1 (Fig.1c). The highest mean bulk density of 0.719 g per ml was recorded for blend T_7 and the lowest of 0.539 g per ml for blend T_1. The increase in bulk density might be

Table 1. Colour values of instant vegetable soup mix

Blends		***L*, a*, b* colour values***				***Mean (Blends)***
		Storage period (days)				
		0	**30**	**60**	**90**	
T_1(100:00:: TP: BP)	L*	49.57	49.12	48.73	48.21	48.90
	a*	17.05	17.35	17.70	17.98	17.52
	b*	31.03	30.59	30.29	29.89	30.45
T_2(95:05:: TP: BP)	L*	49.89	49.41	49.02	48.52	49.21
	a*	15.71	16.04	16.41	16.79	16.23
	b*	30.60	30.19	29.89	29.51	30.04
T_3(90:10:: TP: BP)	L*	50.25	49.72	49.35	48.83	49.53
	a*	14.44	14.75	15.04	15.35	14.89
	b*	30.23	29.80	29.54	29.11	29.67
T_4(85:15:: TP: BP)	L*	50.58	50.10	49.64	49.11	49.85
	a*	13.12	13.47	13.82	14.05	13.61
	b*	29.73	29.42	29.14	28.73	29.25
T_5(80:20:: TP: BP)	L*	50.92	50.39	49.95	49.44	50.17
	a*	11.79	12.10	12.41	12.71	12.25
	b*	29.32	29.02	28.77	28.32	28.85
T_6(75:25:: TP: BP)	L*	51.25	50.68	50.20	49.72	50.49
	a*	10.50	10.83	11.20	11.43	11.00
	b*	28.92	28.65	28.36	27.92	28.46
T_7(70:30::TP: BP)	L*	51.56	50.97	50.46	50.02	50.75
	a*	9.20	9.55	9.87	10.09	9.67
	b*	28.46	28.27	28.00	27.38	28.02
Mean (Storage)	L*	50.57	50.05	49.65	49.12	
	a*	13.11	13.44	13.77	14.05	
	b*	29.75	29.42	29.14	28.69	

Effects	**C.D (p≤0.05)**		
	L*	**a***	**b***
Blends	**0.06**	**0.05**	**0.04**
Storage	**0.05**	**0.04**	**0.03**
Blends× Storage	**0.12**	**0.10**	**0.09**

TP Tomato Powder
BP Broccoli Powder

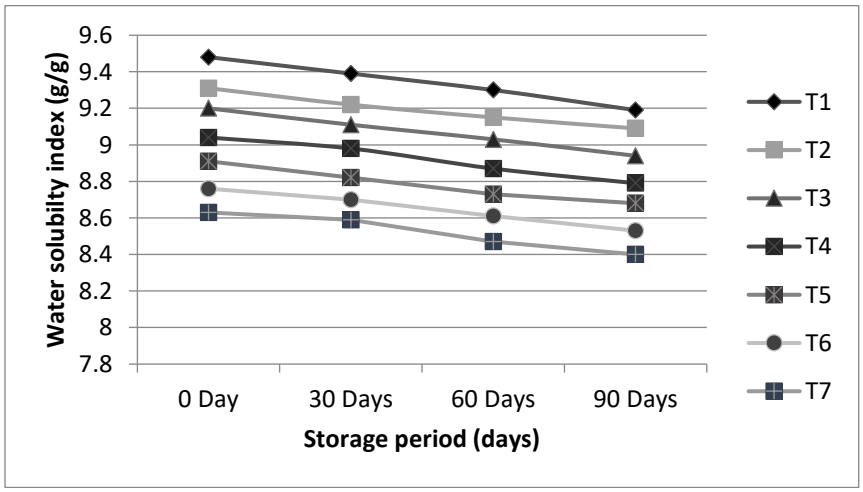
due to increase in proportions of broccoli powder which possessed higher bulk density. With the advancement of storage period, bulk density increased by 4.38 per cent. Among blends, T_7 showed an increase of 12.68 per cent (Fig. 1d) with respect to rehydration ratio which might be due to increase in proportions of broccoli powder possessing higher rehydration ratio. During 90 days of storage, 4.47 per cent decrease was observed in rehydration ratio of soup mix which might be due to decrease in macro molecules like pectin, cellulose and fibre components which are mainly responsible for water absorption during storage.

Fig. 2 showed that the highest overall acceptability score of 7.92 was observed in blend T_4 and the lowest score of 7.19 was recorded in blend T_7. The mean score decreased significantly by 7.96 per cent during 90 days of storage which might be due to change in objective characteristics like loss of colour pigments, breakdown of insoluble solids and overall quality loss in product. Initially, there was no microbial growth in instant vegetable soup mix from 0 to 60 days of storage period but significant increase in microbial count was recorded after 90 days of storage (Table 2). The highest microbial count of 1.62×10^4 cfu per g was observed in blend T_7 whereas, the lowest microbial count of 0.19×10^4 cfu per g was recorded in blend T_1. The increase in microbial count among blends might be due to increasing proportion of broccoli powder which possessed higher moisture content. However, the microbial count did not exceed the standard acceptable limit of $4x10^4$cfu/g in soup FSSAI, [21].

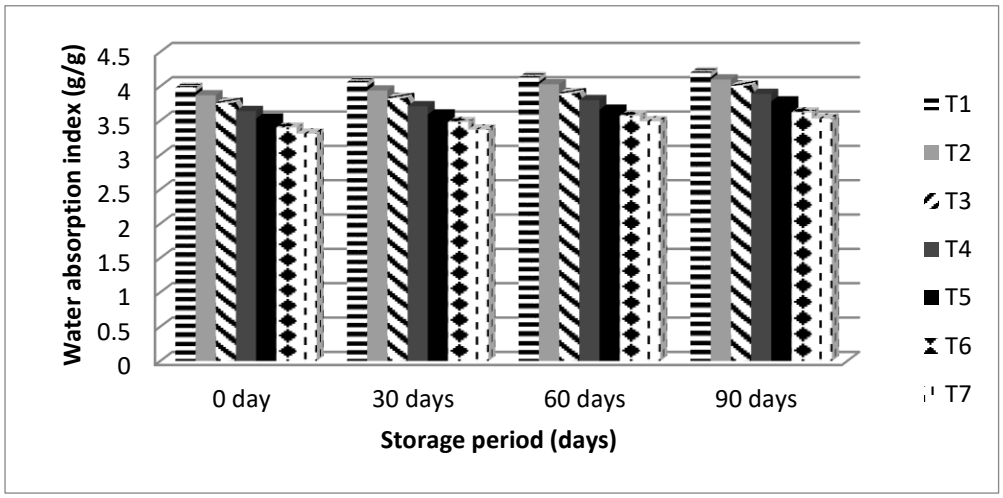
Table 2. Total microbial count ($\times10^4$ cfu/g) of instant vegetable soup mix

Blends	Total microbial count ($\times10^4$ cfu/g) Storage period (days)			
	0	30	60	90
T_1(100:00::TP:BP)	ND	ND	ND	0.19
T_2(95:05::TP:BP)	ND	ND	ND	0.41
T_3(90:10::TP:BP)	ND	ND	ND	0.83
T_4(85:15::TP:BP)	ND	ND	ND	1.04
T_5(80:20::TP:BP)	ND	ND	ND	1.18
T_6(75:25::TP:BP)	ND	ND	ND	1.37
T_7(70:30::TP:BP)	ND	ND	ND	1.62
Mean (Storage)				0.94
Effects	**C.D (p≤0.05)**			
Blends	**0.06**			

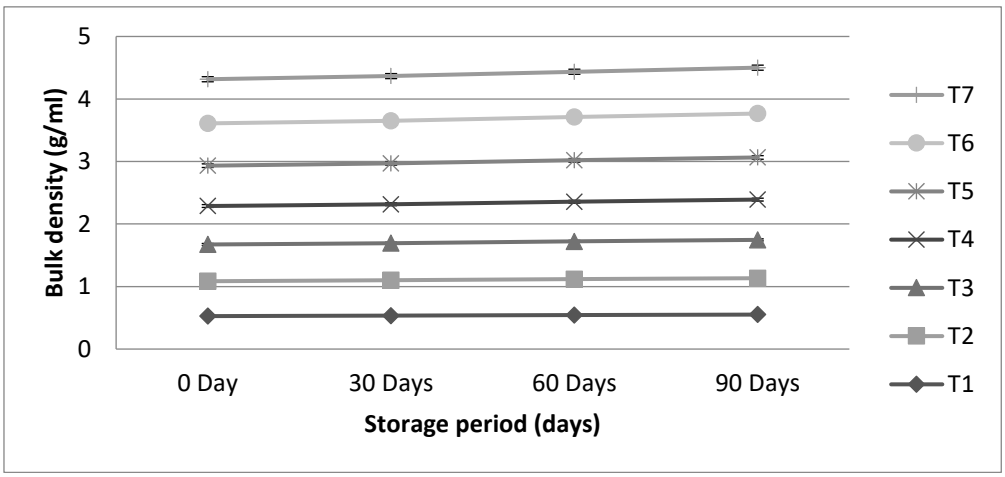
ND: Not Detected
TP Tomato Powder
BP Broccoli Powder



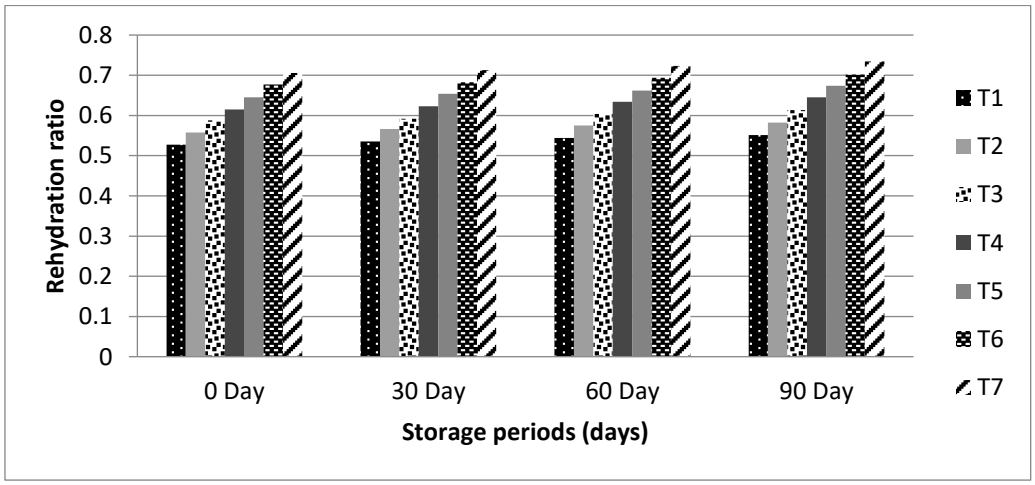
a) Water Solubility Index



b) Water absorption index



c) Bulk density



d) Rehydration ratio

Fig. 1. Effect of blending and storage on functional parameters of instant vegetable soup mix

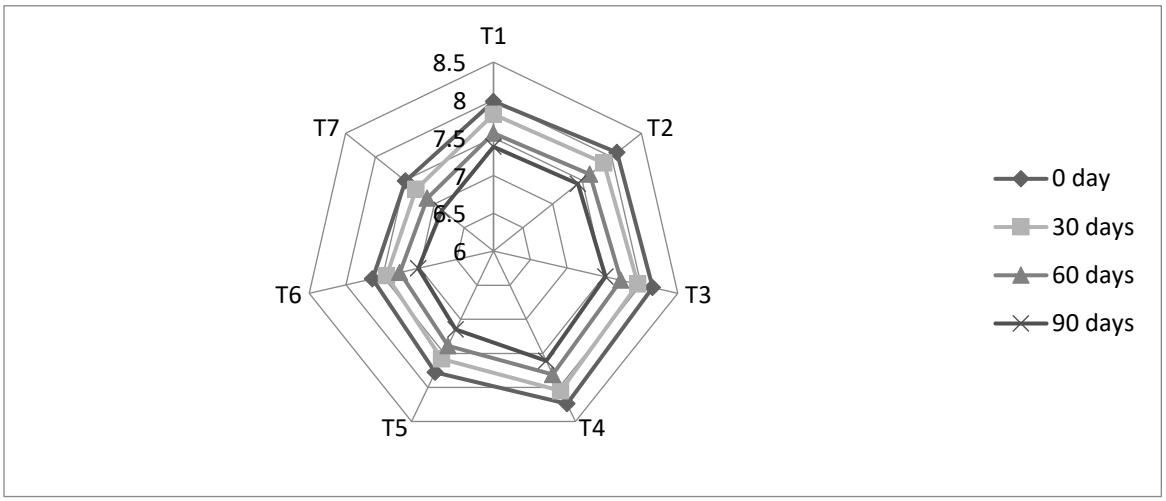


Fig. 2. Overall acceptability (hedonic scale) of tomato-broccoli blended instant vegetable soup mix

From the observations of the experiment it can be concluded that good quality instant vegetable soup mix can be prepared by incorporating 15 per cent broccoli powder with 85 per cent tomato powder. The formulated instant vegetable soup mix retained its quality throughout the storage period of 90 days with the total microbial count within prescribed limits. The instant vegetable soup mix was convenient to use than traditional method of soup formulation in this scenario where increase in consumption of ready-to-eat food is important for reducing the pressure on working population. Hence, the standardized instant vegetable soup mix if incorporated in regular diet can be a healthy option for general masses owing to its higher nutritional quality.

4. CONCLUSION

Thus, in light of scientific data of the present investigation, it was concluded that acceptable quality instant vegetable soup mix can be prepared by incorporating 15 per cent broccoli powder with 85 per cent tomato powder. The formulated instant vegetable soup mix retained its quality throughout the storage period of 90 days with the total microbial count within prescribed limits. With the incorporation of broccoli powder mean L* value increased from 48.90 to 50.75, whereas mean a* and b* values showed a decreasing trend from 17.52 to 9.67 and 30.45 to 28.02, respectively.The instant vegetable soup mix was more convenient than traditional method of soup formulation in this scenario where increase in consumption of ready-to-eat food is important for reducing the pressure on working population. Hence, the standardized instant vegetable soup mix if incorporated in regular diet can be a healthy option for general masses owing to its higher nutritional quality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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