Minerals such as iron and copper are present in seaweeds at higher levels than in many well-known terrestrial sources of minerals, such as cheese, bananas, spinach. Iodine is an important nutrient in metabolic regulation and growth patterns and is abundant in most seaweed. The role of seaweed as a rich source of iodine is particularly relevant in the UK, where recent surveys have highlighted insufficiency in different groups of the population, with iodine being an essential component of thyroid hormones, which are essential for neuro development in utero and after birth (Paul *et al.*, 2007; and Maria and Emilie, 2015).

Vitamins

Seaweeds are a good source of some water-(B_1, B_2, B_{12}, C) and fat-soluble (β-carotene with vitamin A activity, vitamin E) vitamins. To ensure that the adequate intake of all vitamins is received in the diet, people (especially people on special diet, strict vegetarians, and vegans) can consume foods enriched with vitamins, for example, in the form of functional foods with vitamins as nutraceuticals, extracted from natural sources such as seaweeds. Seaweed vitamins are important not only due to their biochemical functions and antioxidant activity but also due to other health benefits such as decreasing of blood pressure (vitamin C), prevention of cardiovascular diseases (β-carotene), or reducing the risk of cancer (vitamins E and C, carotenoids) (Skrovankova, 2011).

From the Table 6 *Laminaria digitata* and *Ulva spp* are good sources for vitamin B_3 and C than other terrestrial foods. Seaweeds are also one of the few vegetable sources of vitamin B_{12}. This may provide an alternate source of vitamin B_{12} for vegetarians or vegans.

Antioxidant and Bioactive Compounds

Antioxidants play an important role in inhibiting and

Table 6: Vitamin Composition of Different Seaweeds and Some Terrestrial Foods

Seaweed	B1	B2	B3	B6	B9	C	E	B12†
(mg per 8 g Dry Portion)*								
Laminaria digitata	0.011	0.011	4.896	0.513	0	2.842	0.275	0.495
Porphyra umbilicalis	0.077	0.274	0.761	0.119	1.003	12.885	0.114	0.769
Ascophyllum nodosum	0.216	0.058	0	0.001	3.648	0.654	0.029	0.131
Undaria pinnatifida	0.403	0.936	7.198	0.259	0.528	14.779	1.392	0.345
Palmaria palmata	0.024	0.08	0.8	0.002	0.021	5.52	1.296	1.84
Ulva spp .	0.06	0.03	8	NA	0.012	10	NA	6.3
Whole Food$ (mg/100 g Edible Portion)								
Bovine milk	0.04	0.18	0.09	0.04	0.08	1.7	0.07	0.4
Emmental cheese	0.02	0.04	0.17	0.01	0.08	6.5	0.28	0.05
Whole wheat	0.48	0.09	5.1	0.27	0.58	-	1.4	-
Carrots	0.07	0.05	0.6	0.27	0.17	7.1	0.47	-
Tomatos	0.06	0.04	0.5	0.1	0.33	19	0.81	-
Spinach	0.09	0.2	0.6	0.22	0.145	2.5	2.5	-
Apple	0.035	0.032	0.3	0.1	0.05	12	0.49	-
Orange	0.08	0.04	0.3	0.1	0.22	5	0.32	-

Note: * Values for seaweeds from the Institut de Phytonutrition (2004). $ Values for whole foods from Belitz (2009). **†:** Values expressed in µg/100 g wet weight. Abbreviations: NA, no data available.

scavenging radicals and thus providing protection to humans against infections and degenerative diseases. A number of marine algae were reported to possess antioxidant properties (Hanan and Mohamed, 2015).

Antioxidant compounds act as free radical scavengers to protect living organisms from the systemic production of Reactive Oxygen Species (ROS), lipid peroxidation, protein damage and DNA breaking (Kokilam and Vasuki, 2014). Many seaweed species verified natural antioxidant capacity that can protect the human body from free radicals and retard the progress of many chronic diseases such as hypertension, heart diseases, diabetes and cancer (Gehan, 2017).

Phenolic and flavonoid compounds were broadly recognized in seaweeds confirming their potent role in chelating metal ions, preventing radical formation and improving the internal antioxidant system under stress environmental conditions. These activities protect the body from progressive diseases caused by the adverse effects of Reactive Oxygen Species (ROS) (Chakraborty *et al.*, 2013). Similar attitude was reported for carotenoid pigments of seaweeds, especially â carotene, for which activity against cancer diseases was postulated (Jane, 2013; and Gehan, 2017).

Extracts from macroalgae or seaweeds are rich in polyphenolic compounds. Which have well documented antioxidant properties. They also have antimicrobial activities against major food spoilage and food pathogenic micro-organisms (Hanan *et al.*, 2015).

CONCLUSION

Seaweeds as a new source of valuable nutrients, food additives nutraceuticals, and nutritional supplements for human and animal consumption. Microalgae and seaweeds have important amounts of macronutrients (proteins, carbohydrates and lipids), vitamins (fat soluble (A and E) and water soluble (C, B_1, B_3, nicotinate, panthotenic acid, biotin, folic acid, B_{12}) minerals, essential and non-essential aminoacids, chlorophylls, carotenoids, polyphenols, polysaccharides, and minerals, although the concentration varies widely among the different species. Specifically, trace elements and minerals are abundant in seaweeds compared to terrestrial foodstuffs, and their non animal nature lends them to use in many food products.

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REFERENCES

- Anonymous (2006), *Food and Nutrition Board, Recommended Dietary Allowances*, 12th Edition, National Academy Press, Washington DC.
- Belitz H D, Grosch W and Schieberle P (2009), *Food Chemistry*, 4th Revised and Extended Edition, Springer-Verlag, Berlin Heidelberg.
- Brigid Mc Kevith (2004), "Nutritional Aspects of Cereals", *Nutrition Bulletin*, Vol. 29, pp. 111-142, British Nutrition Foundation, London, UK.
- Brownle I A, Allen A and Pearson J P (2005), "Alginate as a Source of Dietary Fiber", *Crit Rev Food Sci Nutr.*, Vol. 45, pp. 497-510.
- Chandini S Kumar, Ganesan P, Suresh P V and Bhaskar N (2008), "Seaweeds as a Source of Nutritionally Beneficial Compounds", *J. Food Sci Technol.*, Vol. 45, No. 1, pp. 1-13.
- Chakraborty K, Praveen N, Vijayan K K and Rao G S (2013), "Evaluation of Phenolic Contents and Antioxidant Activities of Brown Seaweeds Belonging to *Turbinaria spp (phaeophyta, sargassaceae)* Collected from Gulf of Mannar", *Asian Pacific Journal of Tropical Biomedicine*, Vol. 3, No. 1, pp. 8-16.
- Dawczynski C, Schubert R and Jahreis G (2007), "Amino Acids, Fatty Acids, a Dietary Fibre in Edible Seaweed Products", *Food Chemistry*, Vol. 103, No. 3, pp. 891-899.
- Devinder Dhingra, Mona Michael, Hradesh Rajput and Patil R T (2012), "Dietary Fibre in Foods: A Review", *J Food Sci Technol.*, Vol. 49, No. 3, pp. 255-266.
- Gehan Ahmed Ismail (2017), "Biochemical Composition of Some Egyptian Seaweeds with Potent Nutritive and Antioxidant Properties", *Food Sci. Technol* [cited January 19, 2017], available from: http://dx.doi.org/10.1590/1678-457x.20316
- Ghada F (2013), "El-Said and Amany El-Sikaily, Chemical Composition of Some Seaweed from Mediterranean Sea Coast, Egypt", *Environ Monit Assess.*, Vol. 185, No. 7, pp. 6089-6099.
- Gomez Ordonez E, Jimenez-Escrig A and Ruperez P (2010), "Dietary Fibre and Physicochemical Properties of Several Edible Seaweeds from Northwestern Spanish Coast", *Food Res. Int.*, Vol. 43, pp. 2289-2294.

- Hanan M Khairy and Mohamed A El-Sheikh (2015), "Antioxidant Activity and Mineral Composition of Three Mediterranean Common Seaweeds from Abu-Qir Bay, Egypt", *Saudi J. of Biological Sci.*, Vol. 22, pp. 623-630.
- Holdt S L and Kraan S (2011), "Bioactive Compounds in Seaweed: Functional Food Applications and Legislation", *J. Appl. Phycol.*, Vol. 23, pp. 543-597.
- Institut de Phytonutrition (2004), "Functional, Health and Therapeutic Effects of Algae and Seaweed", Institut de Phytonutrition Electronic Database, Version 1.5, Institut de Phytonutrition, Beausoleil, France.
- Jane Teas, Sylvia Vena, Lindsie Cone D and Mohammad Irhimeh (2013), "The Consumption of Seaweed as a Protective Factor in the Etiology of Breast Cancer: Proof of Principle", *J Appl Phycol*., Vol. 25, No. 3, pp. 771-779.
- Jimenez Escrig A and Sanchez-Muniz F J (2000), "Dietary Fibre from Edible Seaweeds: Chemical Structure, Physicochemical Properties and Effects on Cholesterol Metabolism", *Nutr Res.*, Vol. 20, pp. 585-598.
- Jimenez Escrig A, Gomez-Ordonez E and Ruperez P (2011), "Seaweed as a Source of Novel Nutraceuticals: Sulfated Polysaccharides and Peptides", *Adv Food Nutr Res*., Vol. 64, pp. 325-337.
- Kokilam G and Vasuki S (2014), "Biochemical and Phytochemical Analysis on and Ulva Fasciata Caulerpa Taxifolia", *Int J. of Pharmacy and Pharmaceutical Sci Res*., Vol. 4, No. 1, pp. 7-11.
- Lahaye M (1991), "Marine Algae as Sources of Fibers: Determination of Soluble and Insoluble Dietary Fiber Contents in Some Sea Vegetables", *J. of the Sci of Food and Agri*., Vol. 54, No. 4, pp. 587-594.
- Mabeau S and Fleurence J (1993), "Seaweed in Food Products: Biochemical and Nutritional Aspects", *Trends in Food Sci & Technol*., Vol. 4, No. 4, pp. 103-107.
- Macartain P, Gill C I R, Brooks M, Campbell R and Rowland I R (2007), "Nutritional Value of Edible Seaweeds", *Nutr. Rev*., Vol. 65, No. 12, pp. 535:543.
- Macrae R, Robinson R K and Sadler M J (1993), "Encyclopaedia of Food Science, Food Technology and Nutrition", Academic Press, London.
- Maria Bouga and Emilie Combet (2015), "Emergence of Seaweed and Seaweed-Containing Foods in the UK: Focus on Labeling, Iodine Content, Toxicity and Nutrition", *Foods*, No. 4, pp. 240-253.
- Marsham S, Scott G W and Tobin M L (2007), "Comparison of Nutrition Chemistry of a Range of Temperate Seaweed", *Food Chem*., Vol. 100, No. 4, pp. 1331-1336.
- Misurcova L, Ambrozova J and Samek D (2011), "Seaweed Lipids as Nutraceuticals", *Adv Food Nutr Res*., Vol. 64, pp. 339-355.
- Murata M and Nakazoe J (2001), "Production and Use of Marine Algae in Japan", *Jpn. Agric. Res. Q*., Vol. 35, pp. 281-290.
- Murugaiyan K, Narasimman S and Anatharaman P (2012), "Proximate Composition of Marine Macro Algae from Seeniappa Dharka, Gulf of Mannar Region, Tamil Nadu", *Int J. of Res in Marine Sci*., Vol. 1, No. 1, pp. 1-3.
- Noer Kasanah, Triyanto, Yuliana Saloso, Wellem Turupadang, Husnul Khotimah, Muhamad Akbar Hakim, Ajeng Diyan Novitasari and Aji Nugroho (2016), "Int Conference and Exhibition on Marine Drugs and Natural Products", *J Pharmacogn Nat Prod*., Vol. 2, No. 3.
- Ortiz J, Romero N, Robert P, Araya J, Lopez-Hernandez J, Bozzo C, Navarrete E, Osorio A and Rios A (2006), "Dietary Fiber, Amino Acid, Fatty Acid and Tocopherol Contents of the Edible Seaweeds Ulva Lactuca and Durvillaea Antarctica", *Food Chemistry*, Vol. 99, pp. 98-104.
- Paul Macartain, Christopher I R Gill, Mariel Brooks, Ross Campbell and Ian R Rowland (2007), "Nutritional Value of Edible Seaweeds", *Nutr Rev*., Vol. 65, No. 12, pp. 535-543.
- Punna Ramulu and Paruchuri Udayasekhara Rao (2003), "Total, Insoluble and Soluble Dietary Fiber Contents of Indian Fruits", *J. of Food Composition and Analysis*, Vol. 16, pp. 677-685.
- Rajasulochana P, Krishnamoorthy P and Dhamotharan R (2012), "Biochemical Investigation on Red Algae Family of *Kappahycus* Sp.", *J. of Chem & Pharma Res*., Vol. 4, No. 10, pp. 4637-4641.
- Romaris-Hortas V, Garcia-Sartal C, Barciela-Alonso M C, Moreda-Pineiro A and Bermejo-Barrera P (2010), "Characterization of Edible Seaweed Harvested on the

Galician Coast (Northwestern Spain) Using Pattern Recognition Techniques and Major and Trace Element Data", *J Agric Food Chem*., Vol. 58, pp. 1986-1992.

- Sanchez-Machado D I, Lopez-Cervantes J, Lopez-Hernandez J and Paseiro-Losada P (2004), "Fatty Acids, Total Lipid, Protein and Ash Contents of Processed Edible Seaweeds", *Food Chemistry*, Vol. 85, No. 3, pp. 439-444.
- Seenivasan R, Rekha M, Indu H and Geetha S (2012), "Antibacterial Activity and Phytochemical Analysis of Selected Seaweeds from Mandapam Coast, India", *J. of Applied Pharmaceutical Sci*., Vol. 2, No. 10, pp. 159-169.
- Shahin Roohinejad, Mohamed Koubaa, Francisco J Barba, Sania Saljoughian, Mehrnoush Amid and Ralf Greiner (2016), "Application of Seaweeds to Develop New Food Products with Enhanced Shelf-Life, Quality and Health-Related Beneficial Properties", available from: http://dx.doi.org/10.1016/j.foodres.2016.08.016
- Skrovankova S (2011), "Seaweed Vitamins as Nutraceuticals", *Adv Food Nutr Res*., Vol. 64, pp. 357-369.
- Susan E Gebhardt and Robin G Thomas (2002), "Nutritive Value of Foods", *Agri Res. Home and Garden Bulletin.*, Vol. 79, p. 9.


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Research Paper ***Open Access***

PROBIOTICATION OF SWEET ORANGE JUICE USING LACTOBACILLUS STRAINS

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A study was carried out for the production of probiotic sweet orange juice using two lactobacillus strains viz., *Lactobacillus delbrueckii* ssp. bulgaricus and *Lactobacillus plantarum*. Encapsulated and free strains were used to prepare the probiotic juice. Prior to juice extraction sweet oranges were treated with activated charcoal solution and lye peeled to prevent delayed bitterness in the juice. Encapsulation of strains was done using a mixture of sodium alginate and guar gum by extrusion technique and the probiotic beads were added to the juice and incubated at 37 °C for 10 hrs. The probioticated juices were studied for sensory acceptability and cell viability for 4 weeks at 4 °C. Microencapsulation of probiotic strains was found to be suitable in maintaining the cell viability in the juice, since viable cells were approximately 9.00 log cfu/ml even after a storage period of 4 weeks. During storage it was found that the viable cell count and sensory score for juice containing encapsulated strains was higher than juice with free strains.

Keywords: Probiotic sweet orange juice, *Lactobacillus delbrueckii* ssp. bulgaricus, *Lactobacillus plantarum*, Encapsulation, Cell viability

INTRODUCTION

Increasing awareness of health and wellness among people and across the age spectrum in the past two decades is fuelling interests in functional foods. Foods are no longer considered only in terms of taste and immediate nutritional needs but also in terms of their ability to provide specific benefits above and beyond their basic nutritional value. Functional foods targeted towards improving the balance and activity of intestinal milieu provides the largest segment of functional food market (Saarela *et al.*, 2000).

Probiotics are live microbial food ingredients, which provide the consumer with numerous health benefits by improving the intestinal microbial balance. However, probiotic foods available in the markets today, are usually in the form of fermented dairy products such as milk and yogurt and thus probiotication of fruit juices is beneficial as fruits and fruit juice based drinks are important components of the human diet. People choose fruit juices as a drink for many reasons, including relieving thirst, refreshment and nutritional benefits. Furthermore, fruits and vegetables do not contain any dairy allergens that might prevent usage by certain segments of the population (Luckow and Delahunty, 2004). Also, fruit and vegetable juices have an established market sector as a functional drink including calcium and vitamin fortified juices. It has been suggested that fruit juices could serve as a good medium for cultivating of probiotics (Mattila-Sandholm *et al.*, 2002).Different studies have been implemented to in- vestigate the suitability of fruit juices such as tomato, orange, grape, carrot, pomegranate, beet and cabbage juices as raw vegetables and fruits for probiotic drink production.

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Lactobacillus plantarum, L. delbrueckii, L. acidophi- lus, *L. casei* and *L. paracasei* have been used as probiotic cultures. Results have shown that all the strains of pro- biotic bacteria are capable of growth in the mentioned juices. Moreover, *L. plantarum, L. acidophilus* and *L. delbrueckii* have shown to be resistant to high acidic and low pH conditions during storage pe- riods at 4 °C for four weeks (Rasic, 2003; King *et al.*, 2007; Mousavi *et al.*, 2011; and Tamminen *et al.*, 2013).

The role of citrus fruits in providing nutrients and medicinal value has been recognized since ancient times. The fruits are known for their refreshing fragrance, thirst-quenching ability, and providing adequate vitamin C as per Recommended Dietary Allowance (RDA). In addition to ascorbic acid, these fruits contain several vitamins and phytochemicals**.** Sweet orange (*Citrus sinensis* L. Osbeck) is a widely grown sweet orange cultivar in India and most popular in Maharashtra, medium to large fruit, thin peeled, juicy nucellar selections available, acidity about 0.35-0.5 per cent when fully mature and hence sweet to ûat taste when stored, slightly acidic fruit with higher acidity and greenish-yellow color rind are better, early maturity (Ladaniya, 2008).

Viability maintenance of probiotic cells throughout food-processing, storage and gastro-intestinal transit is important for the microorganisms to reach the intended site of action in sufficient numbers. International Dairy Federation (IDF) has suggested that a minimum of 10^7 cfu/ml probiotic bacterial cells should be alive at the time of consumption per gram of the product. Probiotic stability in fruit and vegetable juice products is difficult to maintain during cold storage however probiotic encapsulation might solve this problem. Providing probiotic living cells with a physical barrier against adverse external conditions by microencapsulation is an approach currently receiving considerable interest. Microencapsulation helps to separate a core material from its environment until it is released. It protects the unstable core from its environment, thereby improving its stability, extends the core's shelf life and provides a sustained and controlled release (Franjione and Vasishtha, 1995; and Gibbs *et al.*, 1999).

Numerous studies have been carried out on probiotic foods and its health benefits and it is also being increasingly promoted by health professionals. Thus the objective of this study is to determine the suitability of the sweet orange juice as a probiotic drink. Also the present work studies the sensory quality and cell viability of juice with encapsulated strains and free strains during a storage period of 4 weeks.

MATERIALS AND METHODS

Probiotic Strains

The probiotic strains: *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Lactobacillus plantarum* were isolated and identified in Department of Food and Industrial Microbiology, College of Food Technology, VNMKV, Parbhani, Maharashtra and further confirmation of the results were carried out by genotypic identification (16S rRNA multiplex PCR analysis) at ARI Pune.

Preparation of Probiotic Cultures

The lactobacilli strains viz. *Lactobacillus delbrueckii* ssp.*bulgaricus* and *Lactobacillus plantarum* were individually activated in MRS broth at 37 ºC for 24 h and further subculturing was done. The starter culture was prepared by mixing equal amounts of cultivated broths and centrifuged at 4000 rpm for 10min.The harvested cells were washed twice with sterile water to remove the residual MRS media.

Sweet Orange Juice Extraction

Sweet oranges (cv. Mosambi) were procured from the local market of Parbhani, Maharashtra. The rind of the fruits were removed manually and the fruits were dipped in 1% activated charcoal solution and allowed to stand for 1hr.This was done to adsorb the bitter precursors from the fruit surface and the core. The fruits were then lye peeled by dipping it in boiling lye solution (1.5%) for 2 mins to remove the albedo section which is the major contributor of limonin precursors during juice extraction (Sheu and Marshall, 1993; and Teanpaisan *et al.*, 2015). Standardization of the concentration level and time of both the treatments were done based on the extent of broken segments after lye treatment, taste(bitterness reduction) and aroma of the juice. After lye treatment, the fruits were washed thoroughly in running tap water and the remaining alkali was neutralized by dipping in citric acid solution (1%) for 1min and washed again thoroughly. Juice was extracted without pressing the seeds and subsequently the juice was filtered using a strainer and the filtered juice is collected in a dispenser and pasteurized at 90 °C for 2 mins.

Chemical Analysis

Chemical parameters plays a significant role in the quality of the juice and also survival of probiotic cultures. In the