FRUITS AND VEGETABLES BASED PROBIOTIC DRINKS

[1]Chandana Sosalagere

[1]Student

[1]Food science and technology department,

[1]Lovely Professional University, Punjab, India,

Abstract: Probiotics are essential for gut health. Probiotic drinks serve as a delicious way of maintaining gut health. There are several dairy based probiotics in the market. However, Lactose intolerance, vegetarianism and cholesterol call for non-dairy based supplementation. Several fruits and vegetables have been exploited in the recent past for the development of probiotics. Fruits and vegetables are a rich source of essential nutrients, thereby serve as an excellent matrix for the production of Probiotic drinks with maximum health benefits.

IndexTerms **- Probiotics, Non-dairy based, Fruits, Vegetables.**

I. INTRODUCTION

Probiotics are live microorganisms that are ingested for their health benefits (Williams, 2010). The word probiotic comes from Greek which means "for life." The concept of Probiotics took birth in the early 20th century with the idea of altering gut microflora by replacing harmful microflora with beneficial microflora (Williams, 2010). The gastrointestinal tract is colonized by more than 500 different microbial species (Williams, 2010). Some of which are beneficial and the others are harmful. A proper balance between them is usually maintained, however exposure to medication and radiation can hamper it. Probiotics play an important role in establishing the homeostasis (Williams, 2010). Probiotics can be a single microorganism or a mixture of several species of either bacteria or yeast. Such that it is safe, effective, with a long shelf life, without pathogenicity. Lactic acid bacteria, Lacto-bacillus and *Bifidobacterium* species and yeast *Saccharomyces boulardii* are the most commonly used microbes in most of the probiotics. The benefits of Probiotics cannot be generalized as the effects are specific to the strain (Williams, 2010).

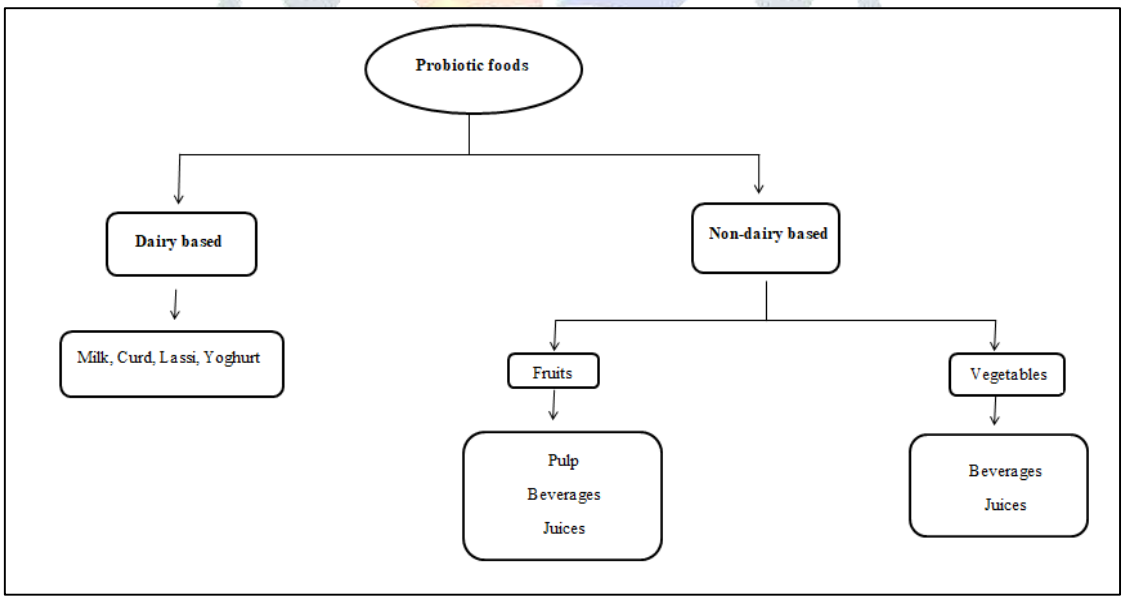

Fig 1. Types of Probiotic foods

II. PRODUCTS

The number of edible sources having the strains of probiotics is increasing day by day. Food products like yoghurt, cheese, buttermilk, ice cream, fermented milks and milk powder are sourced from dairy while products based on collection of juices, soy, cereals are some of the mediums for probiotic transportation which are non-dairy based. Tablets and capsules like Florastor, Reuterina, Enterogermina, UltraLevure, Multibionta are some of the supplements marketed (Rivera-Espinoza & Gallardo-Navarro ,2010). Research has shown that probiotic microorganisms can also be obtained from non-dairy fermented substrates along with animal or human-based sources.

According to certain studies, the probiotic ingestion is limited due to reasons like cholesterol, growing number of buyers who are vegans and lactose intolerant; hence developing the non-dairy based probiotic drinks is need of the hour.

Fruits and vegetables are an absolute source of vitamins (A, C and E) and minerals (magnesium, phosphorus, folic acid and zinc). Presence of several antioxidant contents, dietary fibres and phytochemicals makes fruits an ideal source for functional foods, whereas vegetables are bountiful in components like phytonutrients, phytochemical and carbohydrates (Panghal et al., 2018).

As both fruits and vegetables are plant-based sources and are also free from cholesterol and dairy allergens, it makes them as an ideal substrate for the production non-dairy based probiotic drink (Panghal et al., 2018).

Some of the fruits and vegetable sources used for the production of probiotic drinks are apple, cantaloupe, cashew apple, orange, black currant, bottle gourd, bitter gourd, beetroot, carrot and tomato.

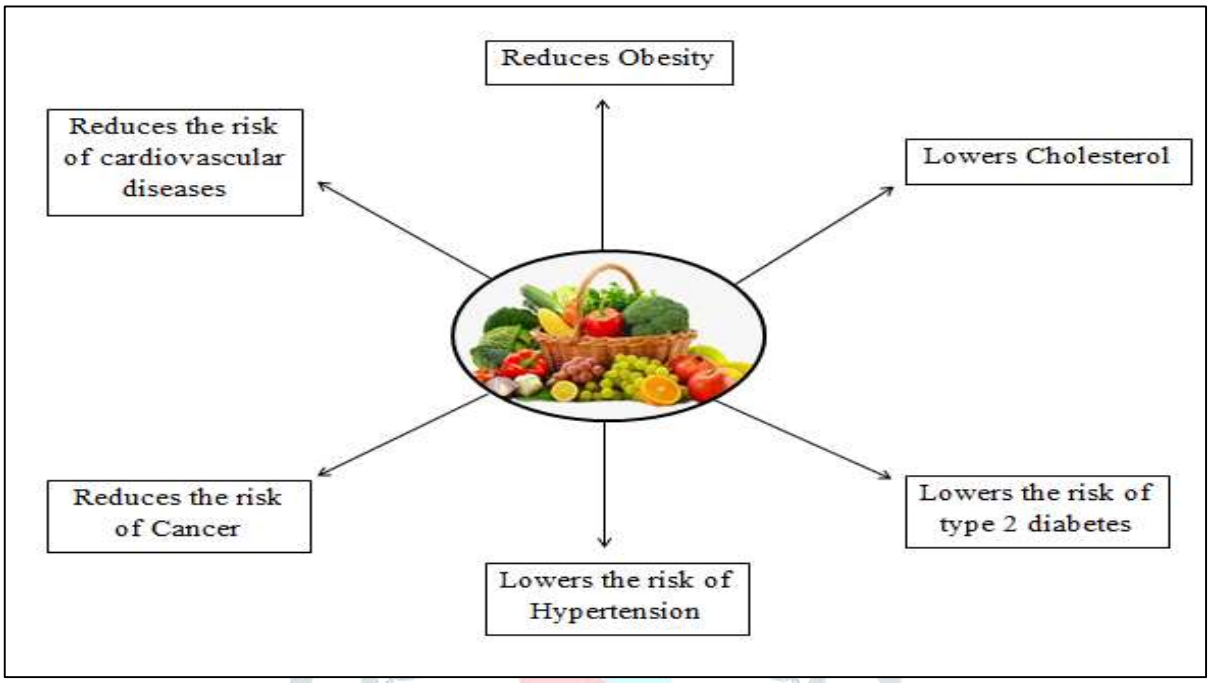

Fig 2. Properties of Fruits and Vegetables

III. FRUITS

3.1 Apple

Dimitrovski et al., 2015 reported that the apple juice was put to use as a growth medium for *Lactobacillus plantarum* PCS 26 strain, a probiotic which was isolated from the traditional cheese of Slovenia. Its cryopreserved culture was revitalized by growing it in Rogosa, de Man, and Sharpe (MRS) broth overnight in partial aerobic conditions at 37°C. Lactobacillus plantarum PCS 26 was used to ferment the apple juice at three different pH values (3.5, 4.2 and 5.1), but only at 5.1 pH a significant growth could be obtained with 1.3 x 1010 CFU/mL in only 11 hours from the beginning of the fermentation. On fermenting the apple juice with whey in 5%v/v highest specific growth rate and the maximal cell concentration was obtained and the live bacteria in the juice helped to maintain the critical value at 106 CFU/mL for a period of 1 month.

3.2 Cantaloupe

Fonteles et al., 2012 conducted a study to optimize the pH, temperature and time of fermentation for the development of a cantaloupe juice derived probiotic fermented drink. They subjected the fermented juice to storage at 4 °C for 42 days. It was observed that the initial pH and temperature contributed to the growth of Lactobacillus casei. Microbial viability however was only affected by temperature. pH=6.1, temperature=31°C were found to be optimum for the growth of Lactobacillus casei. Fermentation time of 8 hours was found to be optimum for the preparation of the probiotic cantaloupe juice. The cell viability of 8.3 log CFU mL−1 was maintained for 42 days. The consistency of the microorganism in cantaloupe juice indicated that melon is a suitable vector for L. casei.

3.3 Cashew apple

Pereira et al., 2011 conducted an optimization study for Lactobacillus casei NRRL B-442 cultivation in cashew apple juice. They also worked on determining the adequate amount of inoculum required, viability of the inoculum and the time required for fermentation. They found that pH 6.4, temperature 30 °C, inoculation level 7.48 Log CFU/mL (L. casei) and 16 h of fermentation was optimum for the production of probiotic from cashew apple juice L. casei flourished in the refrigerated condition and the viable cell count exceeded 8.00 Log CFU/mL throughout the 42 days storage. Other beneficial effects observed were increase in lightness, yellowness and total color change and decreased redness during fermentation. It proved to be as good as dairy products for L. casei growth.

3.4 Pineapple

Nguyen et al., 2019 developed a pineapple-based probiotic drink using bacterial strains like *Bifidobacterium* and *Lactobacillus*. It was observed that after a day of fermentation, bifidobacteria had a cell count of 10^9 CFU/ml whereas lactobacilli had 5^*10^9 CFU/ml. The microbial population had seen no alternate in the first month of storage but in the second month it had a drop in cell viability by 0.11 log cfu/ml. Using bile salts and pepsin, a satisfying cell viability was attained.

3.5 Passion fruit

Santos Monteiro et al., 2020 brought out a probiotic drink using the pulp of passion fruit using the strains of *Lactobacillus reuteri* at the pH of 3.18 under 30° C. The fermented juice was then spray dried for microencapsulation. The presence of acidic molecules and phenolic compounds enhances the quality of the probiotic juice as it's a combination of bioactive compounds and probiotic features.

IV. VEGETABLES

4.1 Red beets

Yoon et al, 2005 reported that *Beta vulgaris* was fermented using *Lactobacillus plantarum, Lactobacillus casei, Lactobacillus delbrueckii, Lactobacillus acidophilus.* All these species of lactic acid bacteria were able to generate lactic acid, though due to cool storage these cultures lost their potentiality but under 4° C, other than *Lactobacillus acidophilus,* all other species had viable cell counts of lactic acid bacteria between 10^6–10^8 CFU/ml even after a month.

4.2 Tomato

Yoon et al., 2004 tested tomatoes for suitableness for the production of probiotic drink using lactic acid bacteria like *Lactobacillus plantarum C3, and Lactobacillus delbrueckii D7, Latobacillus acidophilus LA39, Lactobacillus casei A4.* Tomato based probiotic drink received the attention of lactose intolerant customers and the vegetarians. He stated that the tomato juice was inoculated and incubated with a day-old culture at 30° C. All the four lactic acid bacteria in the fermented tomato juice had a cell count after a month within a range of $10^6 \times 10^9$ CFU/ml under 4° C cold storage. It was observed that the cultures attained an acidity of 0.65 percent and pH turned down to 4.1 and a CFU of 1.0 to 9.0×10^9/ml after fermenting it for 3 days.

4.3 Kombucha

A tea leaves based probiotic drink was developed (Jayabalan et al., 2014). For the production of this drink bacterial strains like *Zygo saccharomyces, Saccharomyces ludwigii, S. bisporus, S. cerevisiae,* and *Torulopsis sp.* were used. This drink is a very good source of polyphenols (catechins) and vitamin C and B_2.

4.4 Bottle gourd

Sharma & Mishra, 2013 produced a fermented bottle gourd juice using bacterial strains like *Lactobacillus plantarum* NCDC 414, *Lactobacillus acidophilus* NCDC 11, and *Pediococcus pantosaceus* MTCC 2819. The juice was extracted from the bottle gourd using a juicer and then warmed for 15 minutes using a water bath at 75° C. The uncontaminated bottle gourd juice was inoculated by a day-old culture having a cell count of less than 10^5 CFU/mL and then incubated for 72 hours at 30° C. The fermented juice was kept for a month under 4° C. It was observed that under 4° C, *Lactobacillus plantarum* potentially survived high acidic and low pH conditions, hence making it a suitable probiotic culture for the production of fermented bottle gourd juice.
They also used carrot and bitter gourd as a matrix for the development of probiotic juice using similar protocol.

4.5 Eggplant

Nguyen et al., 2013 stated that using probiotic strains like *Lactobacillus brevis Lactobacillus fermentum* and *Lactobacillus pentosus,* eggplant juice was fermented to develop a probiotic drink and people of Vietnam are the highest consumers of this fermented drink.

V. CHALLENGES

Fruit and vegetables juices are a favorable matrix for the production of probiotics however, industry scale production of Probiotic drinks from fruits and vegetables have certain drawbacks which include, the effect of the probiotics on the sensory value of the drink and certain parameters which interfere with the survival of probiotics during the production process (Perricone et al., 2015)

The parameters include,

a) microbiological parameters: strain of the probiotics, inoculation rate and proportion.
b) processing parameters: Temperature of incubation, heat treatment, rate of cooling, material employed in packaging and storage.
c) food parameters: pH, molecular oxygen, titratable acidity, water activity, presence of sugars, salt, and chemicals such as bacteriocins, hydrogen peroxide, artificial colouring and flavouring agent (Tripathi & Giri, 2014).

However, this can be overcome by increasing the survival of probiotics in juices by microencapsulation, fortifying the probiotics with prebiotic and addition of antioxidants.

VI. ACKNOWLEDGMENT

I thank Lovely Professional University (Punjab), the management and staff for the support rendered.

REFERENCES

[1] Rivera-Espinoza, Y., & Gallardo-Navarro, Y. (2010). Non-dairy probiotic products. *Food microbiology*, *27*(1), 1-11.
[2] Panghal, A., Janghu, S., Virkar, K., Gat, Y., Kumar, V., & Chhikara, N. (2018). Potential non-dairy probiotic products–A healthy approach. *Food bioscience*, *21*, 80-89.
[3] Dimitrovski, D., Velickova, E., Langerholc, T., & Winkelhausen, E. (2015). Apple juice as a medium for fermentation by the probiotic Lactobacillus plantarum PCS 26 strain. *Annals of microbiology*, *65*(4), 2161-2170.
[4] Fonteles, T. V., Costa, M. G. M., de Jesus, A. L. T., & Rodrigues, S. (2012). Optimization of the fermentation of cantaloupe juice by Lactobacillus casei NRRL B-442. *Food and Bioprocess Technology*, *5*(7), 2819-2826., T. V., Costa, M. G. M., de Jesus, A. L. T., & Rodrigues, S. (2012).
[5] Optimization of the fermentation of cantaloupe juice by Lactobacillus casei NRRL B-442. *Food and Bioprocess Technology*, *5*(7), 2819-2826.
[6] Fonteles, T. V., Costa, M. G. M., de Jesus, A. L. T., & Rodrigues, S. (2012). Optimization of the fermentation of cantaloupe juice by Lactobacillus casei NRRL B-442. *Food and Bioprocess Technology*, *5*(7), 2819-2826.
[7] Pereira, A. L. F., Maciel, T. C., & Rodrigues, S. (2011). Probiotic beverage from cashew apple juice fermented with Lactobacillus casei. *Food research international*, *44*(5), 1276-1283.
[8] Santos Monteiro, S., Albertina Silva Beserra, Y., Miguel Lisboa Oliveira, H., & Pasquali, M. A. D. B. (2020). Production of probiotic passion fruit (Passiflora edulis Sims f. Flavicarpa Deg.) drink using Lactobacillus reuteri and microencapsulation via spray drying. *Foods*, *9*(3), 335.
[9] Nguyen, B. T., Bujna, E., Fekete, N., Tran, A., Rezessy-Szabo, J. M., Prasad, R., & Nguyen, Q. D. (2019). Probiotic beverage from pineapple juice fermented with Lactobacillus and Bifidobacterium strains. *Frontiers in nutrition*, *6*, 54.
[10] Yoon, K. Y., Woodams, E. E., & Hang, Y. D. (2004). Probiotication of tomato juice by lactic acid bacteria. *Journal of Microbiology*, *42*(4), 315-318.
[11] Jayabalan, R., Malbaša, R. V., Lončar, E. S., Vitas, J. S., & Sathishkumar, M. (2014). A review on kombucha tea—microbiology, composition, fermentation, beneficial effects, toxicity, and tea fungus. *Comprehensive Reviews in Food Science and Food Safety*, *13*(4), 538-550.
[12] Sharma, V., & Mishra, H. N. (2013). Fermentation of vegetable juice mixture by probiotic lactic acid bacteria. *Nutrafoods*, *12*(1), 17-22.
[13] Nguyen, D. T. L., Van Hoorde, K., Cnockaert, M., De Brandt, E., Aerts, M., & Vandamme, P. (2013). A description of the lactic acid bacteria microbiota associated with the production of traditional fermented vegetables in Vietnam. *International journal of food microbiology*, *163*(1), 19-27.
[14] Vandamme, P. (2013). A description of the lactic acid bacteria microbiota associated with the production of traditional fermented vegetables in Vietnam. *International journal of food microbiology*, *163*(1), 19-27.
[15] Nguyen, B. T., Bujna, E., Fekete, N., Tran, A., Rezessy-Szabo, J. M., Prasad, R., & Nguyen, Q. D. (2019). Probiotic beverage from pineapple juice fermented with Lactobacillus and Bifidobacterium strains. *Frontiers in nutrition*, *6*, 54.
[16] Tripathi, M.K.; Giri, S.K. Probiotic functional foods: Survival of probiotics during processing and storage. *J. Funct. Foods* **2014**, *9*, 225–241.
[17] Perricone, M., Bevilacqua, A., Altieri, C., Sinigaglia, M., & Corbo, M. R. (2015). Challenges for the production of probiotic fruit juices. *Beverages*, *1*(2), 95-103.
[18] Williams, N. T. (2010). Probiotics. *American Journal of Health-System Pharmacy*, *67*(6), 449-458.