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A review of dairy-based health drinks, looking at current behavior

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Abstract

In today's life, beverages are considered in many ways, because in addition to the role of beverages as food, other roles are considered for them. In some studies, they have been used as a medicine, a carrier of beneficial digestive bacteria and even a source of micronutrients. It is also another important factor, especially in terms of technology, sustainability and the factors affecting it, as well as the impact of micro-coating on product properties. In addition to nutritional, sensory, and functional properties, other factors such as sustainability and even the effects of micro-coating are also effective in various beverages (based on juices and dairy products and dairy and non-dairy fermented beverages). In terms of hosting probiotic bacteria, it was found that in addition to dairy products, fruits and grains are also good sources for hosting these bacteria, especially in the production of beverages. Also, the effect of strain type and pH level along with temperature were identified as the most important factors affecting the survival rate of this type of beneficial bacteria. In the field of flow behavior and fluid engineering, it was finally determined that the behavior of most beverages and food fluids is pseudo plastic and generally predictable with the power law model.

Keywords: Functional drinks, Fruit juices, Dairy products, Fermentation, Flow behavior

Introduction

Today, beverages have a very important share of the food industry market, and various units have focused on the production of beverage industries. On the other hand, with the industrialization of food production, problems such as diabetes, obesity and digestive problems have plagued societies, and this has led to the general popularity of low-calorie products, another goal is to produce healthy food and maximize the use of natural ingredients in the production process to reduce the cost of production and reduce the side effects of consuming artificial substances in the consumer.

Therefore, in recent research, food industry researchers have focused on the production of beverages based on fruits, juices and dairy products, because the agricultural products produced enter the industrial cycle and its waste is reduced, and synthetic flavorings will also be removed from the food basket, and artificial sugars and

sweeteners will have less of a detrimental effect on people's health (Fischer and Schornberg, 2007).

In the study of beverages, various aspects should be considered, such as stability, the effect of compounds on rheological properties and sensory acceptance by the consumer. In terms of stability, the effect of additives, process and storage conditions such as acidity, temperature, gums and sugars are important, and even the specific goal is to replace sugars or gums with healthier flavors while maintaining the desired flavor.

Another area of interest in the production of beverages is their use as hosts for probiotic bacteria such as bifidobacteria and lactobacilli. Survival rate, reproduction rate and bioavailability conditions in the body (bioavailability) are all affected by some production and storage conditions that must be fully considered. Probiotics, according to the standard definition, refer to living and active microorganisms (bacteria and yeast) that are located in different parts of the body (basically intestine) in appropriate numbers, with their biological activity mainly by maintaining and improving the balance of intestinal microbial flora. Among the beneficial and harmful microorganisms, they contain health-promoting properties for the host, so-called products containing these microorganisms are called probiotics. The word probiotic in Latin means life-giving and in the opposite meaning of the word antibiotic (anti-life). On the other side of the prebiotic products are the definition given: Indigestible or slightly digestible compounds against digestive enzymes in the human body (mainly oligosaccharide compounds) that selectively stimulate the growth or activity of probiotic microorganisms. These include fructooligosaccharides (such as inulin). Products that contain both probiotics and prebiotics and actually use the combined use of these two factors in order to create synergies in the health effects are also called synbiotics (Mussatto and Mancilha, 2007).

Due to the fact that today a relatively large part of the consumer market has turnedaway from industrial beverages (such as carbonated beverages) due to nutritional and cognitive health problems, they can be replaced by synthetic beverages by expanding the production of probiotic products. Therefore, in this article, studies have been conducted on the production of beverages based on juices and dairy products and fermented dairy and non-dairy beverages, and then the type of flow behavior in terms of food engineering.

Milk and fruit based drinks

Milk drink - Fruit juice is a type of acidic milk drink that is produced from a mixture of milk and fruit juice and added sugar and stabilizer. Today, in order to prevent the problems of bacterial cultures for acidification of milk and due to the importance of issues related to the economics of production, direct acidification methods such as edible acids or fruit juices are used.

Among the beneficial products that are consumed today, probiotic products have a special place because while reducing the amount of cholesterol and some sugar in them, the presence of structural bacteria will reduce the effects of some diseases such as lactose intolerance and gastrointestinal diseases (Hasheminya et al., 2011).

In another experiment, using barberry and cherry juice, soy milk drink was enriched with different percentages, which while observing the constructive effect of juice on the nutritional properties of fortified soy milk compared to the control sample, it was observed that in the 5-point hedonic sensory test, the addition of juices to soy milk had a significant effect on taste, odor, texture, aroma and overall acceptance of the product (Nazarian et al., 2011; Rahmati Roudsari et al., 2013; Tamer et al., 2006).

Another important issue is the stability of these drinks due to their structure and the acidity of the product environment when the pH of the milk is less than the isoelectric

pH, some phenomena occur, such as the reduction of the zeta potential and the irreversible accumulation of the three-dimensional casein network in the micelles. Gum (hydrocolloids) can be used to prevent the deposition, as well as gypsum mouthfeel, biphasic formation and the formation of clear whey on the surface, with these interpretations, scientists still consider pectin to be the best and most effective gum for this category of products (Pereira et al., 2011).

Another important factor in the stability of beverages is their electrical properties, because the distribution of electrical charges in the product contributes to the uniformity of the texture and the lack of two-phase. For example, regarding the electrical properties, it should be said that changing the amount of whey protein is inversely related to the electrical conductivity of the drink, but the shelf life does not change so much that it is clear that the effect of dairy component (protein) on the final product characteristics (Albanese and Meneguzzo, 2019).

Substitution of natural sugars in beverage formulations is a topical issue in the beverage industry, but what should be considered is the impact of this substitution on other properties of the final product. The results of the recovered powders of date juice showed that under the conditions of date palm juice, with increasing date liquid sugar, the amount of brightness, pH, dry matter and soluble solid (brix) decreases and acidity increases. Date sugar also changed the rheological behavior from Newtonian to pseudoplastic, all indicating the importance of the role of sugar in the properties of the final product (Jalali et al., 2014).

Also, in the field of studying the rheological properties of date milk after adding two types of tragacanth gum, what was observed indicated that the flow behavior, color and particle size of the product are very much affected by the concentration of gum and even the type of gum. The results show that the amount and type of gum not only affects the sensory properties of the product, but also during production affects the flow behavior of the product in pipes and devices, which shows that by calculating these items during the design of lines, the amount of energy required for production can be calculated and a comprehensive view of the economic efficiency of product production can be achieved (Farhadi et al., 2012).

Fermented dairy drinks

Another strategy for using dairy products as pragmatic products is to use them as carriers of probiotics and in the production of food and medicine, in such a case, while producing new products, therapeutic properties are also considered and also probiotics are included in the research, as a result, recombinant probiotics have been successfully engineered to produce a wide range of biologically active proteins from microorganism antigens to human enzymes and cytokines. Mucosal vaccination against infectious diseases, transfer of bioactive proteins to reduce chronic inflammatory disorders and autoimmune diseases, treatment of allergies and supplementation of metabolic defects have been discovered. GI ducts are a mucosal site of interest for the transport of such molecules, and studies in animal models have provided the basic information that this technology can now be transferred to human use. Therefore, the transfer of therapeutic proteins to the GI ducts for the treatment of chronic inflammatory bowel disease and some allergies is the most successful example of the use of recombinant probiotics (Fenster et al., 2019).

Probiotic bacteria include Lactobacillus and Bifidobacteria, which after consumption, have effects such as controlling the growth of viruses and pathogenic bacteria, stimulating the immune system, reducing infections and modulating intestinal pH in the consumer. In a study on the role of these products in the health cycle, it was found that the use of probiotic cultures in the dairy industry has become a tool for the development of new products, and

probiotics can even be seen as an adjunct to medication or even as a mainstay of treatment (Markowiak and Śliżewska, 2017).

In the fermented beverage containing Propionibacterium freudenreichii along with Lactobacillus acidophilus, the presence of this bacterium was found to have no effect on the stability of the beverage and the two-phase production of the product, also, the highest survival rate is in the ratio of 1 to 8 of these two bacteria compared to each other and their viability has an inverse but significant relationship with the greenhouse temperature, which was determined as the best temperature of 30 degrees Celsius. Another important point is their shelf life, which was set at a maximum of 28 days at standard food storage temperature (Voosogh et al., 2009).

During a study, the effect of process variables on the production of vitamin B12 in fermented dairy beverages containing propionic acid inoculated with Propionibacterium freudenreichii was investigated, which showed the final results, the volume and method of inoculation and concentration of molasses (as the initial medium for culture) did not affect the production of vitamin B12, but on the other hand, the source of nitrogen and feed were identified as the most effective factors in the production of this vitamin. Therefore, soaked corn syrup and lactose significantly increased the production of the mentioned vitamin in the product, which by considering all the above factors, the optimal conditions with the highest efficiency were obtained (Keshtkaran et al., 2012).

Another research in the field of beverage product enrichment is related to Sohrabi et al. (2016) who found; First, although fermented and unfermented beverages containing vitamin E have the same nutritional properties for the target group, fermented beverages have much higher sensory scores. Second, for groups on restrictive diets, fermented beverages completely inhibit restrictive microstructures while providing essential micronutrients. Third, because it is a rich source of protein in whey protein, it can be a good alternative to chemical boosters for consumers on special diets.

Non-dairy fermented beverages

Lactic acid bacteria have always been considered by food industry experts for their use in industry due to their attractive and popular flavors in food, as well as their resistance to growth against pathogens and spoilage agents during storage, one of the applications of these microorganisms is in the production of fermented foods derived from fruit juices as prebiotic fermented beverages.

Cereal grains are one of the main sources of nutrients around the world and due to having a number of compounds, they also have physiological effects and can selectively stimulate the growth of Lactobacillus and Bifidobacteria as probiotic bacteria in the intestine. For this reason, today the industry has changed its view on using them to produce beverages based on fermentation from cereals, the simultaneous use of cereals and milk, which are the two main and of course rich sources of nutrients, has made the complete set available to the consumer.

A noteworthy point for researchers in this field is the long history of producing such products, especially in Southwest Asia and the Indian subcontinent. In summary, the importance of these drinks is that cereals are a rich source of energy and nutrients, however, some cereals lack some essential amino acids and their sensory properties are weak compared to wheat, rice and other animal and plant foods, fermentation is one of the most common technologies to increase the nutritional value and acceptability of such products. Despite the production of such products around the world, but they have not been considered scientifically and industrially, and their production is often limited to home scale and since these products have high shelf life and good nutritional properties compared to

pre-processing conditions and microbial flora are responsible for natural fermentation and include strains of lactic acid bacteria and yeast, standardization of technology and production of such products on an industrial scale, while being a healthy choice for consumers, is also very economically viable, an important aspect in the production of these products, in addition to nutritional and micronutrient issues, are the presence of bacteria and fermentation agents, which certainly play a key role in digestive processes and improve health (Holzapfel, 2002).

In the last case, apple juice was tested and the result, while producing an acceptable taste, by removing the color, as an important factor in the acceptance of food, especially beverages, during the storage period, the product was accepted, the point is that the type of strain selected should be appropriate to the conditions of the material used because each of the strains in a temperature range, acidity and temperature show the best productivity (Pereira et al., 2011; Angelov et al., 2006).

Study of beverage flow behavior

In general, dairy drinks cover a wide range, the simplest type of which includes milks mixed with sugar and flavoring and stabilizing substance, and other types that are mixed with herbs or tree sap, other types of dairy drinks are fermented, such as yogurt, milk-juices, and cereal-based fermented beverages, but in similar products, pieces of fruit, pulp, seeds, nuts, and concentrates have replaced the juice.

From the point of view of engineering and flow behavior, it should be said that beverages consumed on a daily basis generally follow a relationship independent of time and relaxation. To better explain the behavior of flows in fluids, the various conditions and their descriptive relationships are given below. Models describing fluid flow behavior in a general division are divided into two categories, time-dependent and time-independent, which have been identified according to studies, the behavior of juices and the behavior of juices and beverages is generally independent of time, ie with increasing the duration of force on the fluid, its viscosity will not change and its behavior is not affected by applying more time to the force (Rao, 2014).

One of the equations of prediction in time-independent conditions is the power law model, which itself is composed of different types of fluids. These types of fluids are defined as hardening (dilatant) and relaxing (pseudoplastic) whose equations are as follows:

$$\tau = k\dot{Y}^n \quad (1)$$

K: Fluid consistency coefficient ($Pa.s^n$ or Ns^nm^{-2})

Another behavior that we can imagine for this group of fluids (although all scientists agree that such behavior is ideal and does not exist externally) is ideal plastic or St. Venant, in the sense that increasing the strain in the fluid does not need to increase the applied stress and in the constant stress line, the strain increases. The other case can behave similarly to the law of fluids, except that a threshold force in the fluid is required to start the flow, this initial required force is called the yield stress and is denoted by τ_0. In this type of fluid, the relationship between stress and strain is linear, which we call Bingham fluids. The latter case describes a loosening or hardening condition that also has a yield stress and is called in the scientific discussion of caisson or Herschel-Balky fluids.

$$\tau = k_0\dot{Y}^n + \tau_0 \quad (2)$$

In this equation τ_0 is the same as the yield stress, k is the fit factor or consistency index and n is the pseudoplasticity constant or strength index. The Casson model also describes yield stress fluids with pseudoplastic or dilatant properties, the relationship of which is as follows:

$$\sqrt{\tau} = k0 + k\sqrt{\dot{Y}} \quad (3)$$

Where k_0 and k are the constants of the Casson equation in terms of $Pa^{0.5}$ and $Pa^{0.5}.s^{0.5}$. To calculate the yield stress of caisson (τ_{0c}, Pa) and the plastic viscosity of caisson (η_c, Pa.s), it is sufficient.

$\tau_{0c} = (k_0)^2$, $\eta_c = (k)^2$

Also, for ease of comparison between models and understanding their differences, different models have been compared through a table of behavior changes (Norton et al., 2011).

Table 1. Relationship between flow type and values of τ_0 and n according to Herschel-Bulkley

Fluid type	n	τ_0	Equation
Newton	1	0	$\tau = k\dot{Y}$
Pseudoplastic	0<n<1	0	$\tau = k\dot{Y}^n$
Dilatant	n>1	0	$\tau = k\dot{Y}^n$
Ideal plastic or St. Venant	0	>0	$\tau = k + \tau_0$
Bingham Plastic	1	>0	$\tau = k\dot{Y} + \tau_0$
Pseudoplastics have yield stresses	0<n<1	>0	$\tau = k\dot{Y}^n + \tau_0$
Dilatant behavior with a yield stress	n>1	>0	$\tau = k\dot{Y}^n + \tau_0$

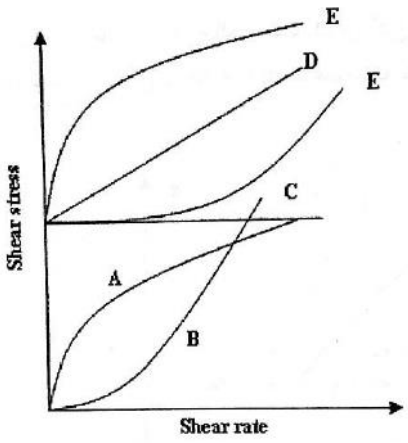

Figure 1. Rheogram of time-independent fluids (Line A: Pseudoplastic fluid; Line B: Dilatant fluid; Line C: Ideal plastic or St. Venant; Line D: Bingham plastic fluid; Line E: Casson type plastic fluid)

Conclusion

In the field of beverage usefulness, the presence of probiotic bacteria has facilitated digestion in consumers of the beneficial product compared to consumers of the control product. From a technological point of view, it was concluded that the most important factors affecting the flavor of the product are the type of bacteria, temperature and shelf life. In terms of stability, pH, the share of juice in the formulation and the

amount of gums, and of course the type of gum are effective in reducing the two-phase rate and stability of the product. In the case of host ingredients, it was also found in fermented products that cereals along with fruits can be a good host for fermenting bacteria. An important issue is the behavior of engineering flow in beverages in such a way that by examining them, the energy required for pumps, piping and packaging equipment, and even the type of packaging and storage method can be determined, From all the research, what has been found is that the main behavior of beverages is relaxing and usually follows the model of the law of power, These findings help to predict the behavior of beverages at different stages of industry and consumption with a more realistic view.

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