



## Potential and differences of selected fermented non-alcoholic beverages

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### ABSTRACT

Fermentation has been used by a humans for centuries, basically to extend a shelf life of a product. But these days, fermented food and beverages can provide probiotic bacteria and more bioavailable nutrients to organism. There are numbers of fermented food and beverages, depending on region, culture or production method. The aim of this study was to compare last research concerning fermented, non-alcoholic beverages based on whey, fruit or vegetables.

**Keywords:** Fermentation, fermented beverages, whey, fruit and vegetables, water kefir, probiotics, alcohol content

### 1. INTRODUCTION

Fermentation is one of the oldest processes used during food production and processing. Basically, fermentation leads to acquiring product characterized by longer shelf life and higher suppression of spoilage and pathogenic microorganisms growth. However, with the rise of food processing industry, fermentation became a specific process, which can be controlled. Besides preservation, fermentation imparts characteristic aroma, flavour, texture, and nutritional profile into food. Thus, although ancient civilizations developed fermentation primarily as a way of preserving perishable agricultural produce, the technology has evolved

beyond preservation into a tool for creating desirable organoleptic profiles in food and improving their palatability [1].

Not only fermented food is the product of microorganisms activity during the fermentation process but also beverages are very well-known and worldwide-scale consumed products. What is very interesting, almost every region in the world has its own recipe for fermented beverage. Due to several environmental factors, such as temperature, climate, microorganisms present in the air and, mainly, sources used to processing, such beverages can vary significantly [2]. Exploitation of such sources as milk (several types), cereals, tea, fruit and vegetables, whey and even solution of water and sugar provides very wide range of fermented beverages. What is more, its functional character, such as health-promoting properties, natural composition, compounds higher bioavailability, presence of live microorganisms and novel organoleptic profile are main opportunities, which are getting more and more recognized by the consumer.

Potential of functional food and beverages is very high: The global functional drinks market had total revenues of \$70,162.8m in 2014, representing a compound annual growth rate (CAGR) of 7.8% between 2010 and 2014. Market consumption volume increased with a CAGR of 7.8% between 2010-2014, to reach a total of 22,224.5 million liters in 2014. The market experienced strong growth from 2010-2014, and is expected to continue to grow (at a slower rate) for the forecast period up to 2019 [3].

The aim of this study was to compare different non-alcoholic fermented beverages to enlighten its potential and differences. Literature concerning whey, fruit and vegetables-based beverages has been reviewed.

## **2. POTENTIAL OF FERMENTED NON-ALCOHOLIC BEVERAGES. LITERATURE REVIEW**

### **2. 1. Whey as a substrate of fermented beverage**

Whey is a by-product obtained from cheese manufacture, which was often disposed of in the past [4]. Nevertheless, whey is a nutritive highly appreciated product which is insufficiently used in human nutrition [5]. Fermentation of a whey beverage itself, reconstituted whey, addition of hydrocolloids, soy isoflavones and phytosterols, fruit, inulin or buttermilk was considered after the literature review. Several authors [6-10] tried to determine the sensory profile and rheological characteristics of products varied by different microorganisms content and other factors.

Skryplonek, K., Jasińska, M. [6] tried to “define quality properties of beverages based on fresh acid whey and milk with addition of buttermilk powder or sweet whey powder”. *Lactobacillus acidophilus* La-5 and *Bifidobacterium animalis* Bb-12 were used as fermenting microorganisms. Research showed that beverage with *L. acidophilus* enriched with buttermilk powder had the best sensory scores.

E. Seyhan, H. Yaman and B. Ozer [7] used *Lactobacillus acidophilus* LA-5 and *Lactobacillus casei* LBC-81 to ferment whey beverages in 37 °C and then stored. Supplementation of whey beverages with soy isoflavones or plant sterol negatively affected the viability of *Lb. acidophilus* LA-5 throughout the storage period, but the phytosterol-added samples received the highest sensory scores for each individual evaluation criteria. What is

interesting, panel group assessed phytosterol-added samples as more acidic than isoflavones-added ones.

I. Drgalić, L. Tratnik, R. Bozanić [5] fermented reconstituted whey with *Lactobacillus acidophilus* La-5, *Bifidobacterium bifidum* Bb-12 and *Lactobacillus casei* Lc-01. Additionally, researchers used inulin (as a prebiotic stimulating bacteria growth) to enrich whey beverage. Inulin addition had an almost negligible effect on bacterial count. As authors claim, “The best sensory scores were given to samples which were fermented for 18 h. The sensory scores of products fermented for less than 18 h were too mild and without a sour taste while samples fermented for 24 h were too sour”. Comparing to previous mentioned research [7], where panel group assessed more acidic samples as more attractive by overall aroma, taste and perception, it can be concluded that acidity is a very significant factor due to whey fermented beverages. On the other hand, J.S. Farah, C.B. Araujo, L. Melo [8] assessed sensory acceptance of whey-based beverages available on the local market. Whey-based beverages were accepted comparable to yoghurts, but authors emphasized the problem of similar labels, which provides products hard to differentiate. That could be a significant issue because of strong difference between yoghurts, drinking milks and whey-based beverages, which were the subject of mentioned study. Above all, whey fermented beverages can be characterized by a higher nutritional value, valuable minerals like easily absorbed calcium and phosphorus and it is a source of vitamins B and vitamin A [6].

Moreover, whey contains: 0.50-0.55% of beta-lactoglobulin (source of essential and branched chain amino acids), 0.20-0.25% of alpha-lactoalbumin (primary protein found in human breast milk also of essential and branched chain amino acids), 0.10-0.15% of immunoglobulins (primary protein found in colostrum with immune modulating benefits), 0.01-0.02% of lactoferrin (antioxidant, antibacterial, antiviral and antifungal agent which promotes growth of beneficial bacteria), 0.005% of lactoperoxidase (inhibits growth of bacteria), 0.05-0.10% of bovine serum albumin (large protein which is source of essential amino acids) and 0.10-0.15% of glycomacropeptide (source of branched amino acids that lacks aromatic amino acids such as phenylalanine, tryptophan and tyrosine) [10].

F. J. Gallardo-Escamillaa, A. L. Kellya, C. M. Delahuntyb [9] tried to evaluate the sensory characteristics of fermented whey after addition of several hydrocolloids within a narrow range of physical viscosities, similar to that of commercial fermented milk. High-methoxy pectin (HMP), propylene glycol alginate (PGA), carboxymethyl cellulose (CMC) and xanthan gum (XG) were added separately to whey fermented by a yoghurt starter culture. Sweet, acid and yoghurt flavour components were assessed what corresponds with previously mentioned research. Hydrocolloid PGA caused considerable grittiness, thus CMC and HMP were described as enhancing the viscosity of whey-based lactic beverages, although both will tend to mask the typical flavor of yoghurt when using a yoghurt culture, which seems to be, next to viscosity, significant parameter for higher sensory value. What is more, concentrations of volatile compounds characteristic of yoghurt odor in the headspace of the fermented whey samples were measured. These compounds were acetaldehyde, ethanol, acetone, dimethyl sulphide, butadiene, acetoin, 2-furfural. Appropriate materials, process conditions and additives could influence concentration of such compounds, thereby causing product more attractive to the consumer.

To sum up, whey is basically the by-product of cheese- making process, however it is characterized by a great potential of use in functional, non-alcoholic fermented beverages. Its nutritional values and several development opportunities were studied by many authors. The

use of additives to improve its organoleptic properties and stability during storage were considered. In this work, organoleptic properties and consumer's acceptance were enlightened intentionally, as this factor is crucial, together with healthiness and availability, by the basic Polish definition of quality [11].

## **2. 2. Fruit or vegetables as a substrate of fermented beverage**

Fruit and vegetables have been appreciated mainly for its nutritional values, therefore it is the basis of food pyramid [12]. Moreover, the use of fruits and vegetables in fermented foods and beverages is known for centuries, as a significant part of countries cuisines. E.g. juniper beer- a fermented drink made with juniper berries as the main ingredient, usually accompanied by honey and hops, has been made in many parts of northern Poland. Similar drinks were also made in other countries around the Baltic Sea, e.g. Estonia and Finland. The use of this beverage became nearly completely obsolete in the mid-20th century but was resurrected in the Kurpie area in NE Poland and now receives a lot of media attention. The tradition of making this drink in northern Europe may have prehistoric origins as remnants of a similar beverage were found in some archeological sites in Denmark dating back to 1500 B.C. [17].

Beetroot kvass is a beverage from Polish Traditional Products List of Polish Ministry of Agriculture and Rural Development [13]. It is traditionally prepared during Christmas as a basis of borsch. It is obtained by the spontaneous lacto-fermentation of sliced beet in water solution. Beet is a source of sugars for LAB, as it is characterized by very high extract. In such beverages like beetroot kvass, in the aftermath of fermentation process, decline of carbohydrates content is observed. 100 ml of fermented beverage has a lower caloric value than 100g of substrate [14].

Shalgam juice is a fermented black carrot juice. This traditional Turkish beverage is red coloured, cloudy and sour. It is produced by lactic acid fermentation of a mixture of turnips, black carrot, bulgur (broken wheat) flour, salt and water. Its composition has been reported by F. Altay et al. [15] after other authors, as total dry matter (2.0–4.0%), protein (0.09-0.018%), salt (1.1-2.2%), lactic acid (0.578-8.05 g/L), ash (1.46-2.06%), and ethanol (0.79-6.41). What is more, it has been reported to contain anthocyanin as cyanidin-3-glycoside (88.3-114.1 mg/L). What is important, is the fact that it is mainly homebrewed beverage. This may explain significant differences in mentioned parameters values.

Another Turkish fermented, non-alcoholic beverage based on fruit is Hardaliye. It is less popular than Shalgam, due to its local character. It is consumed in the Thrace in the Marmara region of Turkey. Hardaliye is mostly manufactured homemade by the traditional method. Red grape (Papazkarasi, Alfons or Cardinal) or grape juice and crushed black mustard seed and cherry leaf are used for hardaliye production. Washed red grapes and mustard seeds are pressed separately till the rupture of their crusts. The ruptured crust of grapes gives the dark colour to final product depending on grape varieties. Pressed grapes and cherry leaves are placed into a barrel and 0.2% pressed mustard seeds and/or 0.1% of benzoic acid are added.

The barrels are closed and incubated at room temperature for 5-10 days. After incubation, the mixture is filtered and kept at cold [15].

Juniper beer, beetroot kvass, shalgam juice and hardaliye are examples of fermented, non-alcoholic beverages, obtained from different, non-common substrates. But what is important, not only substrates are significant to acquire high-quality, innovative or functional product. Processing method and microbiota are equally important. Fermentation of fruit or

vegetable juices can be also provided with use of water kefir grains, which are described to contain dextran, an  $\alpha$  1–6 linked glucose polymer. A strain of *Lactobacillus hilgardii* was identified to produce large amounts of the granule-forming dextran in water kefir and characterized the glycosyltransferase responsible for the production of this dextran [16]. Fruit or vegetable juices can provide sugars and nutritious compounds to LAB included in dextran grains. E.g. O. Corona et al. [18] fermented several juices obtained from carrots, fennels, melons, onions, tomatoes, and strawberries by back-slopping method. In back-slopping a batch of a fermented product is used to inoculate the new batch. This procedure produces higher initial number of beneficial microorganisms than found in raw material and ensures a faster and more reliable fermentation than occurs in spontaneous fermentation [19]. Results indicated that lactic acid bacteria and yeasts were capable of growing in the juices tested. Melon juice registered the highest numbers of microorganisms. Almost all juices underwent a lactic fermentation. After fermentation, there was observance of a decrease of the soluble solid content and an increase of the number of volatile organic compounds [18]. What seems significant is the ethanol content after fermentation process present in every sample besides onion-based kefir-like beverage. Carrot, melon and strawberry- based kefir-like beverages contained more than 2% v/v of ethanol. It can be connected with the high sugars content in mentioned samples. Moreover, these samples were characterized by significant contents of CO<sub>2</sub>, what proves its advanced fermentation process level. Discussed research provided characterization of novel fermented vegetable juices with a high potential, which, additionally, were appreciated by the panel group after sensory evaluation.

Further research of previously mentioned authors [20] showed, that fermentation of Mediterranean fruit with water kefir grains is also possible. In this study, apple, quince, grape, kiwifruit, prickly pear and pomegranate were subjected to fermentation. Fermented kefir-like beverages based on fruits were analyzed to contain i.a. ethanol, lactic acid, acetic acid and CO<sub>2</sub>. Few samples- kiwifruit, prickly pear, quince contained even more ethanol than vegetable-based beverages, what suggests that it could be a significant issue, as this study refers non-alcoholic fermented beverages. High-alcohol content may be a product of yeasts activity and this issue should be considered in further investigation.

### 3. CONCLUSIONS

Fermented food and beverages are very significant source of probiotic bacteria and can provide many valuable and more bioavailable compounds to human organism. Moreover, fermentation process often change sensory profile of a substrate, which is found to be an opportunity for novel products, more attractive to the consumers. This study refers to fermented, non-alcoholic beverages, based on non-common substrates: whey – the by-product of cheese production and fruit and vegetables. After the literature review, several conclusions were formulated:

1. Whey is a valuable substrate for non-alcoholic fermented beverages. Fermentation can be provided by *Lactobacillus acidophilus*, *Bifidobacterium animalis*, *Lactobacillus casei* or *Bifidobacterium bifidum*.
2. Several additives can be used in whey beverages, to acquire better physical and chemical parameters and stability of beverage during storage.

3. Sensory evaluation seems very significant due to novel whey-based fermented beverages, as the substrate is characterized by a very specific flavor and aroma.
4. Juniper beer, beetroot kvass, shalgam and hardaliye are examples of fermented, non-alcoholic beverages based on non-common substrates. The use of the other fruits or vegetables may be considered to produce innovative beverages.
5. Ethanol content in high-extract fermented juices can be a significant issue. Alcohol and CO<sub>2</sub> content should be precisely described and controlled.

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