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Effect of processing variables on the physico-chemical characteristics and aroma of *borş*, a traditional beverage derived from wheat bran

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ABSTRACT

Borş is a traditional Romanian beverage obtained by naturally fermenting an aqueous suspension of wheat bran and corn flour, used as flavoring enhancer in local gastronomy since ancient times, and more recently consumed as refreshing drink. To investigate the changes in sensory, physico-chemical, phenolic and aroma composition resulted after two successive fermentations, *borş* samples were subjected to standard, sensory, HPLC and GC/MS analysis. Total phenolic compounds and ferulic acid, the most abundant phenolic compound, were positively influenced by natural starter addition, increase of fermentation temperature, and thermal treatment, whereas the effect on less abundant phenolic acids was not univocal. The variables had the same effect on antioxidant activity and brown index. Volatiles (alcohols, carboxylic acids, esters), pungent-sour and goat milk-cheese odor notes increased at higher fermentation temperature, whereas bran and yogurt odor notes decreased. The addition of a natural starter at 4 °C allowed balancing odor intensity and antioxidant activity.

1. Introduction

Numerous traditional beverages of ancient origin, appreciated in the area of production but almost unknown abroad, are obtained by fermenting aqueous suspensions of cereal meals: *chicha*, derived from corn and consumed in South America (Blandino, Al-Aseeri, Pandiella, Cantero & Webb, 2003); *bushera*, obtained from sorghum or finger millet flour and consumed in Uganda (Muyanja, Narvhus, Treimo & Langsrud, 2003); *oshikundu*, from sorghum and pearl millet flour, and *maxau*, from corn flour, both produced in Namibia (Misihairabgwi & Cheikhyoussef, 2017); *boza*, obtained from millet, corn, wheat or rice and consumed in Turkey, Greece, Bulgaria, Albania, and Bosnia Herzegovina (Arici & Daglioglu, 2002); *kvass*, typically produced from rye flour or stale rye bread in Russia and in several Eastern Europe countries (Baschali, Tsakalidou, Kyriacou, Karavasiloglou & Matalas, 2017); *tarhana*, obtained in Turkey by fermenting wheat flour with yogurt and dried after production, then rehydrated at the moment of use to prepare soups (Kilci & Gocmen, 2014). In addition, the recent interest towards non-dairy milk substitutes and functional beverages has prompt the production of innovative fermented beverages from emmer (Coda, Rizzello, Trani & Gobbetti, 2011).

Another fermented cereal-based beverage is the Romanian *borş de tărâţe*, also called simply *borş*: a sour liquid obtained by natural fermentation of an aqueous suspension of wheat bran – "*tărâţe*" means "bran" in Romanian – and corn flour (Nicolau & Gostin, 2015). *Borş* is traditionally used in Romania (especially in Moldova and, more rarely, in Transylvania) either to prepare a wide range of sour soups, named *ciorbă*, or to be consumed plain as a drink (Grosu-Tudor, Stancu, Pelinescu & Zamfir, 2014). *Borş* is also referred to as "white *borş*" to distinguish it from the red one (commonly spelled *borsh* or *borsch*), obtained from the juice of beetroot in several countries of Central and Eastern Europe (Nicolau & Gostin, 2015).

Wheat bran, the main ingredient of *borş*, is commonly destined to animal feed, but alternative uses have been recently proposed due to its content of lipophilic and hydrophilic antioxidants such as tocopherols, tocotrienols, and phenolic compounds. In fact, bran oleoresin and bran aqueous extracts – the latter very similar to *borş* but not fermented – have been used to produce functional pasta (Pasqualone et al., 2016).

The starter of *borş* is always obtained through spontaneous fermentation. Several lactic acid bacteria have been isolated from *borş*, able to produce bacteriocins (Grosu-Tudor et al., 2014). *Borş* preparation follows a slightly different recipe from one area of Romania to another, although the Moldavia region, in the Eastern part of the country, has the strongest tradition for this kind of fermented

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beverages. After thoroughly mixing bran, corn flour and water, the obtained suspension, put in a not tightly closed container, is kept in a fresh place (approximately 15 °C, but with large seasonal variations) for 2–3 days (Anonymous, 2017). Then, the suspension is filtered, bottled and stored at 4 °C. Part of the solid sediment (called *huşte*) is retained for being used as natural starter (equivalent to sourdough in bread-making) to get the successive batch of *borş* (Anonymous, 2011a), whose formulation can also include sour cherry leaves, lovage and dill, all with flavoring purposes.

Besides being produced at home for personal consumption, many artisanal producers sell unpasteurized *borş* in the produce markets. However, nowadays *borş* is also produced by industrial companies, which usually pasteurize it (Anonymous, 2017). The shelf-life of this product can therefore increase from one month (unpasteurized *borş*) to two years (pasteurized *borş*), in proper storage conditions. *Borş* acts as a probiotic, when consumed raw, or prebiotic, when consumed pasteurized or cooked in soups (Nicolau & Gostin, 2015).

No studies have been aimed at defining the effect of processing variations on the quality of *borş*. The aim of this research, therefore, has been to assess the effect of fermentation temperature, pasteurization, and use of starter, on the physico-chemical characteristics and aroma of *borş*.

2. Materials and methods

2.1. Sample production

The experimental design and the sampling points are schematized in Fig. 1. *Borş* was prepared in two trials, one carried out by spontaneous fermentation, the other carried out by inoculating the natural starter obtained in the first trial. The ingredients used for *borş* preparation, i.e. wheat bran (*Triticum aestivum* L.) (carbohydrates 68.8 g/100 g d.m., proteins 2.3 g/100 g d.m., lipids 3.9 g/100 g d.m., fiber 25.1 g/100 g d.m.) and corn flour (*Zea mays* subsp. *mays*) (carbohydrates 85.6 g/100 g d.m., proteins 7.7 g/100 g d.m.; lipids 1.9 g/100 g d.m., fiber 4.9 g/100 g d.m.) were purchased at local retailers. In detail, 300 g of wheat bran and 60 g of corn flour were thoroughly mixed with 3 L tap water. The obtained suspension was then divided into three batches – A, B and C – each of it allowing to ferment spontaneously for 3 days, at 4 °C, 14 °C, and 24 °C, respectively, in a not tightly closed glass bottle put in a thermostatic cell (GTest-TM, Fratelli Galli, Milan, Italy), for both the starter preparation (solid fraction) and the recovering of *borş* (liquid fraction). At the end of the first trial, the suspension was filtered and a portion of the solid sediment (60 g) was recovered from each batch, to be used as natural starter (traditionally called *huşte* in Romanian) for repitching in the next successive fermentations. The filtered liquid was divided in two aliquots: the first was put in 250 mL bottles and pasteurized at 20 pasteurization units (PU) (samples 1AP, 1BP, 1CP) in a thermostatic bath (Thermovisc 100-F8, Fungilab, Barcelona, Spain), while the second was left unpasteurized (samples 1ANP, 1BNP, 1CNP).

Therefore, the recipe and fermentation were repeated as in the first trial, but inoculating the natural starter (60 g). Sampling was carried out as described above with pasteurized samples coded 2AP, 2BP and 2CP, and unpasteurized samples coded 2ANP, 2BNP, 2CNP. This procedure was adopted according to the traditional practice that involves to produce *borş* by using a little amount of sediment from the precedent batch.

Two commercial samples of *borş*, coded COM1 and COM2, were purchased at local retailers and were included in the sample set as reference. These commercial samples were from two different companies settled in the Eastern part of Romania, in the Moldavia region, which has a tradition for this kind of fermented beverages. COM1 was pasteurized and had a shelf-life of 2 years (stored at maximum 25 °C, avoiding direct sunlight). COM2 was unpasteurized and had a shelf-life of 30 days (stored at 4 °C). The producers of both commercial samples stated in the label that the product had to be consumed within 72 h after opening.

All the samples were kept at −20 °C until being analyzed.

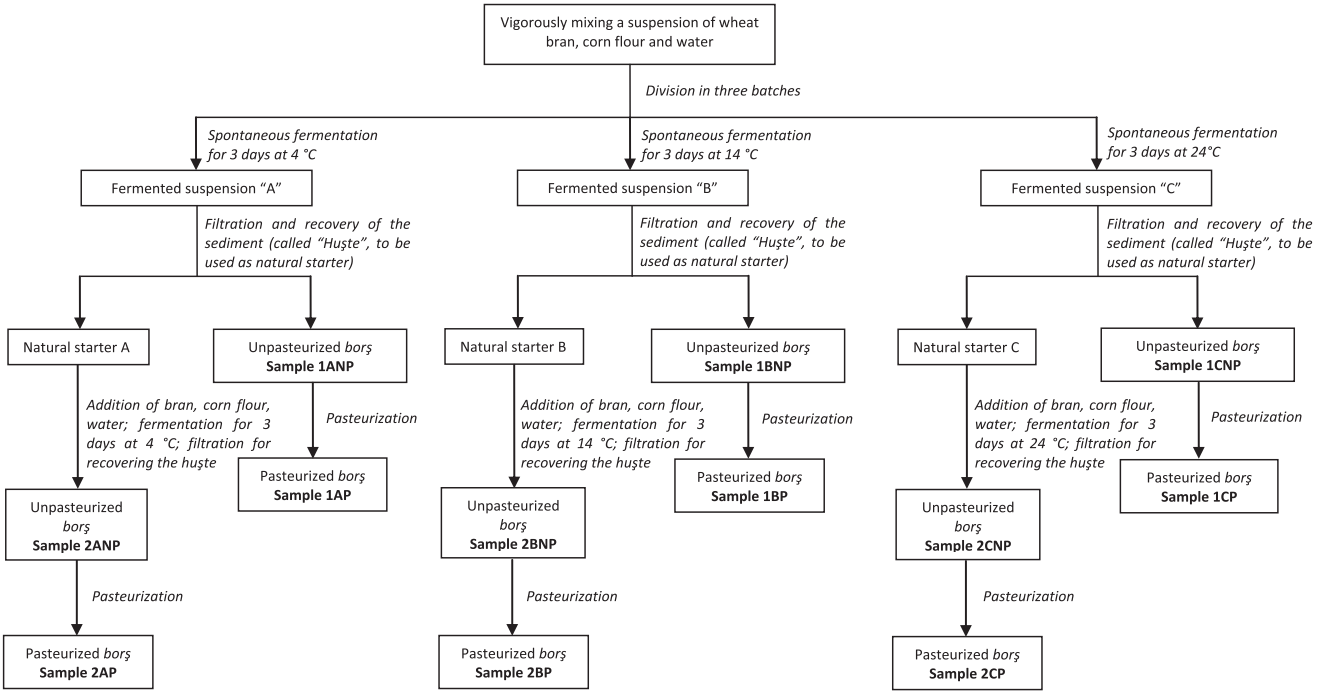

Fig. 1. Experimental design and sampling points during of *borş* production. In sample codes, the letters "A", "B", and "C" indicate three different fermentation temperatures: 4, 14, and 24 °C, respectively; number "1" is referred to spontaneous fermentation whereas number "2" is referred to fermentation carried out by inoculating the natural starter obtained in the spontaneous one; the letters "NP" and "P" indicate "not pasteurized" and "pasteurized", respectively.