Sauerkraut and sour turnip consumption habits in Slovenia

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Abstract

Introduction: Fermentation is one of the earliest methods of food preservation. Along with the extended shelf life of foods, the fermentation process provides also higher safety and better organoleptic properties of the products. The fermentation can be carried out by the naturally occurring microbial community or by the addition of the so-called starter cultures. The metabolic activity of microorganisms significantly affects the bioavailability and concentration of bioactive compounds in the product. However, the viability and number of beneficial living microorganisms depend on many factors, such as storage and processing conditions of the foods. *Methods:* In order to obtain the data on the knowledge and eating habits of sauerkraut and sour turnip among Slovene people, an online questionnaire was prepared. The obtained data were analysed using IBM SPSS Statistics 26 and Microsoft Excel. *Results:* In the present questionnaire-based survey 175 individuals were included (24 M; 151 W). The majority of the participants showed great knowledge about fermented foods and their health benefits. Moreover, half of participants prepare fermented foods at home. In the last month the vast majority consumed cooked ($n = 152$) or raw ($n = 121$) sauerkraut, while the lower proportions consumed cooked ($n = 54$) or raw turnip ($n = 95$). Only a few ($n = 14$) did not consume any. Among consumers on average 204 g of cooked and 179 g of raw sauerkraut and 188 g of cooked and 136 g of raw sour turnip was consumed in the last month. *Discussion and conclusion:* By regular and adequate consumption of sauerkraut and sour turnip, both raw and heat-treated, a beneficial effect on the immune and digestive system and the general health of the working-age population could be achieved. However, live probiotic microorganisms can positively affect human health only when consumed in sufficient concentration, which is at least 10^8 to 10^{10} CFU per day. The last could be achieved by a daily intake of

100 g of product with at least 10^6 CFU ml^{-1} live microorganisms. Considering this study results, the intake of live microorganisms only by raw sauerkraut or turnip consumption among Slovene people is not sufficient to achieve a probiotic effect.

Keywords: sauerkraut, sour turnip, fermentation, microorganisms

Introduction

Fermentation is a traditional food preservation method used to extend shelf-life, safety, and impart desirable organoleptic properties of the foods (Shiferaw Terefe, 2016). This food processing technology utilizes the growth and metabolic activity of microorganisms for the stabilization and transformation of food raw materials (Di Cagno, Coda, De Angelis and Gobbeti, 2013). Fermentation of vegetables, fruits, and grains most often includes lactic acid fermentation involving different species of lactic acid bacteria (LAB) (Steinkraus, 1992). In addition to spontaneous fermentation, the controlled fermentation can be carried out by the addition of starter culture, a standardized community of microorganisms. However, the diversity of the microbiota markedly depends on the intrinsic and extrinsic parameters of the plant matrix (Di Cagno et al., 2013). Furthermore, the growth of spoilage and pathogenic organisms is inhibited by high salt concentrations, LAB metabolites, and the consequent decline of pH value (Shiferaw Terefe, 2016).

Sauerkraut is one of the most common and oldest forms of raw vegetable preservation. It is produced by spontaneous fermentation of cabbage under anaerobic conditions, with the addition of salt. The fermentation process takes several weeks at a temperature of 15 to 20 °C (Oregon et al., 2016). Important strains of bacteria present in sauerkraut are *Leuconostoc mesenteroides*, *Lactobacillus plantarum*, and other genera like *Leuconostoc*, *Lactobacillus*, *Pediococcus* and *Weissella* (Touret, Oliveira and Semedo - Lemsaddek, 2018). Like sauerkraut, the sour turnip was an important food in ancient times, consumed mainly in the winter months. Raw material is prepared by placing the washed turnip into a vat, in Italian culture the turnip was alternatively layered with grape skins. Before covering the vat, a mix of water and salt or water only is added and left for 30 to 40 days at 12 to 15 °C. The most commonly represented LAB are *Lactobacillus hilgardii* and *Pedococcus parvulus* (Maifreni, Marino and Conte, 2004). Nevertheless, due to the presence of live microorganisms that possess probiotics properties, antimicrobial, antioxidant and peptide production, fermented foods are known for its beneficial nutritional and functional properties for consumer's health (Septembre-Malaterre, Remize and Poucheret, 2018; Şanlıer, Gökçen and Sezgin, 2017).

Methods

In the first part of the study literature review on the fermentation process with the focus on vegetables was made including the scientific articles not older than

10 years. To obtain the data on the knowledge and eating habits of sauerkraut and sour turnip among Slovene people, an online questionnaire was prepared. The obtained data were processed using Microsoft Excel and SPSS Statistics 26.0 (IBM, Armonk, NY, USA).

Results

The health benefits of fermented vegetables can be associated with their prebiotic and/or probiotic potential, due to the presence of live microorganisms and their metabolites, such as bioactive peptides, short-chain fatty acids or polysaccharides (Septembre-Malaterre, et al., 2018; Şanlıer et al., 2017). Probiotics are live microorganisms that, when consumed in sufficient amounts, may confer a health benefit for the host (FAO/WHO, 2002). They help maintain good balance and composition of the intestinal flora, preventing the invasion of pathogenic microorganisms (Tripathi and Giri, 2014), improve immunity and calcium absorption, reduce the risk of intestinal diseases (Homayouni, Pavahoo and Azizi, 2012), lower serum cholesterol and blood pressure (Rašić, 2003). Most of the commercially used probiotics belong to LAB group, including *Lactobacillus*, *Leuconostoc*, *Streptococcus*, and *Enterococcus* genera (Yadav, 2017). To achieve positive effects, foods should contain the required minimum number of live microorganisms with a probiotic effect at the time of ingestion. The recommended standard for probiotics live cell counts is at least 10^6 CFU mL⁻¹ of the product (Neffe-Skocińska, Rzepkowska, Szydłowska and Kołożyn-Krajewska, 2018). Furthermore, many LAB species have antimicrobial activity due to the production of antimicrobial active metabolites, such as organic acids, hydrogen peroxide and other compounds, such as bacteriocins and antifungal peptides (Reis, Paula, Casarotti and Penna, 2012). Moreover, produced bioactive peptides are known for the functional properties, such as immunomodulatory, antithrombic and antihypertensive effect (Tamang et al., 2016).

In the present study, we focused mainly on sauerkraut and sour turnip, both a result of LAB fermentation. In data analysis of a questionnaire-based survey 175 individuals were included (24 M; 151 W). Based on the study results, the majority of the participants showed excessive knowledge about fermented foods and their health benefits (Table 1). To begin with, half of the participants prepare fermented foods at home. The majority (> 60 %) of them agreed with statements as follows: (i) salt addition inhibits the action of unwanted microorganisms and allows the reproduction of the desired ones; (ii) temperature is an important factor in the fermentation process; (iii) an anaerobic environment must be established for fermentation; (iv) sugars are converted to acids during fermentation and (v) that the pH of the food before and after fermentation varies. Although, the majority of them knew that fermented foods have an extended shelf life (81 %), only half of them agreed that fermented foods are more microbiologically safe.

Table 1: Respondents agreement with the statements

Statement	I do not agree	I neither agree not disagree	I agree
We need to add salt, which inhibits the action of unwanted microorganisms and allows the reproduction of the desired ones.	14 (8 %)	34 (19 %)	127 (73 %)
Temperature is an important factor in the fermentation process.	6 (3 %)	18 (10 %)	151 (86 %)
We need to provide anaerobic conditions.	23 (13 %)	40 (23 %)	112 (64 %)
In the fermentation process, sugars are converted to acids.	13 (7 %)	50 (29 %)	112 (64 %)
The pH value of a food changes (pH value allows us to define a substance as acidic, neutral or basic).	2 (1 %)	24 (14 %)	149 (85 %)
Fermented foods have an extended shelf life.	7 (4 %)	27 (15 %)	141 (81 %)
Fermented foods are more microbiologically safe.	14 (8 %)	67 (38 %)	94 (54 %)
Fermented foods are richer in vitamins.	33 (19 %)	70 (40 %)	72 (41 %)

Regarding the consumption in the last month, the vast majority consumed cooked ($n = 152$) or raw ($n = 121$) sauerkraut, while the lower proportions consumed cooked ($n = 54$) or raw turnip ($n = 95$). Only a few ($n = 14$) did not consumed any. On average 204 ± 176 g of cooked and 179 ± 150 g of raw sauerkraut and 188 ± 172 g of cooked and 136 ± 136 g of raw sour turnip was consumed in the last month.

Discussion

During food fermentation, functional microorganisms transform raw material constituents, thereby enhancing the nutrition value, sensory properties and safety, degrading toxic substances, producing antioxidant and antimicrobial substances (Tamang Shin et al., 2016). Sauerkraut and sour turnip are locally produced processed vegetables and are also used as major components of traditional Slovenian foods (Korošec, Golob, Bertoncelj, Stibil and Koroušić Seljak, 2013). As expected, this study participants showed good knowledge about the fermentation process. Surprisingly, the lowest level of agreement was for a statement about the fermented foods being a better source of vitamins than raw material. However, as reviewed before, the probiotic, antimicrobial and antioxidant effects of fermented vegetables have a beneficial potential for human health (Tamang Shin et al., 2016). We focused mainly on the probiotic effects of sauerkraut and sour turnip. Live microorganisms with a probiotic potential can have a positive effect on our health only if consumed in sufficient amount, which means at least 10^8 to 10^{10} CFU per day (FAO/WHO, 2002). This would mean consuming 100 g of food with at least 10^6 CFU mL⁻¹. Oregon et al. (2016) found that 100 g of sauerkraut contains 5×10^6 CFU. Considering present study results, the intake of live microorganisms e.g. by 179 g of raw sauerkraut per month, meaning 3×10^5 CFU per day is not in accordance with recommendations. Furthermore, the microorganisms found in sauerkraut and sour turnip are diverse and not all have probiotic effects (Zabat, Sano, Wurster, Cabral

and Belenky, 2018). It should also be noticed that many fermented foods are heat-treated after fermentation to enhance food safety, which can significantly influence the number of microorganisms (Rezac, Kok, Heermann and Hutkins, 2018).

Conclusions

The live microorganisms with probiotic properties present in fermented foods have a beneficial effect on intestines, prevent the action of pathogenic microorganisms, improve the immune system, and general health. Considering this study results, the intake of live microorganisms only by raw sauerkraut or sour turnip consumption among Slovene people is not sufficient to achieve a probiotic effect. Therefore, the intake of probiotic microorganisms with other foods or dietary supplements is recommended. With regard of the questionnaire results, the benefits of Slovene traditional food should be more promoted.

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