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Dietary intake and knowledge of fermented food products among university students

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Abstract

Aim: This study examined the knowledge and consumption patterns of fermented foods among undergraduate students, comparing those enrolled in Food and Nutrition programs with students from other academic disciplines.

Methods: A cross-sectional survey of 328 Canadian university students gathered demographic data and assessed familiarity, understanding, and intake of fermented food products.

Results: While 78% of students reported familiarity with fermented foods, only 23% could accurately define fermentation. Students in Food and Nutrition programs demonstrated stronger knowledge, correctly answering 67% of related questions versus 62% in other disciplines (p = 0.07; 90% CI). Consumption rates were high overall, with 96% of participants reporting they consumed fermented foods. Significant differences were found between groups in specific categories: fermented fruits and vegetables (p = 0.02), soybeans (p = 0.002), grains (p = 0.02), and meat products (p = 0.017). Regarding frequency, 36% of students consumed a variety of fermented foods weekly, while 30% reported monthly consumption.

Conclusions: Cultural background, taste preference, and educational focus also appear to influence dietary behaviors. Enrollment in a Food and Nutrition program was linked to both higher knowledge and increased intake. To the best of our knowledge, this is the first Canadian study to explore differences in fermented food knowledge and consumption across academic disciplines. These results support the potential of education-based strategies to promote healthier dietary patterns and warrant further research across more diverse populations.

Keywords

Fermented foods, knowledge and consumption, functional foods, University students, Nutrition studies

Introduction

Historically, fermentation was primarily used to preserve food, improve shelf life, and enhance flavor of food products [1, 2]. Over time, fermented foods became dietary staples in many cultures, and scientific

interest grew due to their potential health-promoting properties. Microorganisms involved in fermentation, particularly lactic acid bacteria (LAB), are now studied for their ability to produce beneficial compounds such as vitamins, minerals, and bioactive peptides. The conjugated linoleic acids and bacteriocins have shown various health effects including anti-microbial, anti-inflammatory, and blood pressure-lowering properties [1]. While research has delved into the beneficial bacteria present in fermented foods, such as fermented dairy products, kombucha, and fermented vegetables, there is less research on the knowledge and consumption patterns of fermented foods.

Fermented foods contain functional microorganisms that impart a positive effect on health beyond basic nutrition. Functional micro-organisms present in food include probiotics in fermented dairy products [2], symbiotic culture of bacteria and yeast present in kombucha [3, 4], and lactic acid bacteria (LAB) in fermented vegetables [5, 6]. Functional properties of fermented food have been shown to have a positive effect on cognition and memory [7, 8], improve digestive health [9, 10], and enhance immune function [5, 11]. Fermented soy products such as tempeh, natto, and miso are recognized for their high content of bioactive compounds, particularly peptides and isoflavones, which are generated through the fermentation process. These bioactive compounds undergo bioconversion in the gastrointestinal tract, where they may exert various health-promoting effects, including antioxidant, anti-inflammatory, and lipid-lowering activities [12]. Research indicates that a student's field of study can significantly influence their dietary choices and nutrition knowledge, with those enrolled in health-related programs often demonstrating healthier eating behaviors compared to students from other academic disciplines [13, 14]. This association underscores the importance of educational background in shaping food selection and consumption patterns.

While the current literature has addressed the types of fermented foods available in the market, and their enhanced functional properties, there is little evidence regarding the knowledge and consumption patterns of fermented foods among university students, specifically in the Canadian population. The nutritional qualities and therapeutic properties of fermented food products have been widely studied, but the reasoning for why and what types of fermented food products individuals select and their rationale for the use of fermented products is unknown. The objective of this study was to assess the knowledge and consumption patterns of fermented food products among undergraduate students and to determine if there is a difference in knowledge and consumption patterns of fermented food products among Food and Nutrition and Non-Food and Nutrition undergraduate students.

Materials and methods

Subjects

The study sample consisted of 328 undergraduate students enrolled at Brescia University College in London, Ontario, Canada. Of these, 180 were students in a Food and Nutrition program, and 148 were from Non-Food and Nutrition disciplines. Eligibility criteria included being over 18 years of age and fluent in English. The majority of participants (n = 295) were female and Canadian citizens, representing a range of cultural backgrounds. Participants ranged in age from 19 to 32 years, with a mean BMI of 22.8 ± 5.4 kg/m^2.

Data collections

This study was conducted at Brescia University College among undergraduate students during class time. At the start of the term, course instructors were contacted to confirm interest and schedule availability, with at least two professors from each discipline invited to participate. A classroom recruitment script was read to students, followed by a letter of intent; completion of a one-time, 10-minute survey implied consent. Students who had previously completed the survey in another class were asked not to participate again. The survey included demographic questions, frequency questions to assess consumption patterns, and true-or-false items to evaluate knowledge. This study received approval from the Western Research Ethics Board (Project ID: 114997).

Statistical analysis

In this study, descriptive statistics were used to summarize demographic data and survey responses. Independent samples *t*-tests were applied to compare knowledge scores between Food and Nutrition students and students from other disciplines ($p < 0.05$). Chi-square tests were used to assess relationships between categorical variables such as frequency of fermented food consumption, familiarity, and knowledge. The statistical software for this study includes SPSS 25, R 3.6.3, and Jamovi 1.0.

Results

Knowledge of fermented foods

Participants completed a series of true-or-false knowledge questions covering the benefits of consuming fermented foods, the fermentation process, and common misconceptions. An independent samples *t*-test revealed that students enrolled in Food and Nutrition programs demonstrated a higher level of knowledge compared to those from other academic disciplines, correctly answering 67% of knowledge questions versus 62% ($p = 0.07$, 90% CI). This increased knowledge among Food and Nutrition students was reflected in their greater reported consumption of various fermented foods, including soybeans, grains, fruits, vegetables, and meat products, suggesting a positive association between nutrition knowledge and intake. Specifically, most participants (70%, Table 1) correctly understood that fermentation does not always produce alcohol as an end product [15]. Furthermore, 72% accurately identified that fermented foods contain a combination of bacteria, yeast, and molds rather than solely beneficial bacteria [9, 15, 16]. Sixty-five percent recognized that fermented foods may help reduce symptoms of lactose intolerance in individuals who are lactose intolerant [5, 17], and 60% were aware that not all fermented foods are pasteurized, as some functional foods undergo high-pressure processing while products like kimchi and kombucha often remain unpasteurized [6, 18, 19]. Approximately half of respondents (52%) correctly identified that not all fermented foods contain probiotics, which are primarily found in fermented dairy products [20]. These findings support the conclusion that higher nutrition knowledge corresponds with improved understanding of fermentation and fermented food consumption.

Table 1. Knowledge of fermented foods among respondents

Aspect	Finding
Fermentation and alcohol production	70% correctly identified that fermentation does not always result in alcohol production
Microorganisms	72% correctly identified that fermented foods contain bacteria, yeast, mold, or a mix
Lactose intolerance	65% identified that fermented foods may help decrease symptoms of lactose intolerance
Pasteurization	60% knew that not all fermented foods are pasteurized
Probiotics	52% knew that not all fermented foods contain probiotics, primarily in fermented dairy products

When participants were asked about their familiarity with the term “fermented foods”, 78% (Table 2) of participants perceived that they were familiar with this term and the types of products available. However, while participants may believe themselves to be familiar with the term “fermented foods”, only 23% of respondents could correctly define the term fermented foods when asked to describe them in a short answer question. A definition was considered correct if the response contained key terms and synonyms that described the process of fermentation, such as bacteria, yeast, spontaneous, carbon dioxide, alcohol, and anaerobic or aerobic [15]. Those who were familiar with fermented food products reported consuming them on a weekly (36%) or monthly (30%) basis. The most commonly listed food products cited when asked for examples of fermented foods included yogurt, kombucha, kimchi, sauerkraut, and alcohol. Forty-four percent of respondents were able to identify one health benefit of consuming fermented foods, mostly commonly citing improved gut microbiota and increased nutritional properties.

Table 2. Familiarity and consumption of fermented foods

Aspect	Finding	Aware/Reported	Key insight
Familiarity with the term	Participants reported familiarity with the term "fermented foods"	78%	High perceived familiarity but low definitional accuracy
Definition accuracy	Participants could correctly define "fermented foods"	23%	Indicates a gap between perceived and actual knowledge
Consumption frequency	Participants consumed fermented foods weekly or monthly	36% weekly 30% monthly	Fermented foods are regularly consumed by a significant portion
Health benefits identified	Participants identified at least one health benefit	44%	Most common: improved gut microbiota, better nutritional properties

Consumption of fermented foods

The consumption patterns of various fermented food categories are shown in Table 3. Respondents were asked about their consumption of multiple fermented food items based on food categorie which included fruit and vegetables, dairy, beverages, soybean products, grains, and meats. The most commonly reported single food item from each food category was pickles from fruit and vegetables (67%), yogurt from dairy products and alternatives (86%), wine from fermented beverages (65%), miso from fermented soybean products (36%), soy sauce from fermented grain products (75%), and salami from fermented meat products (49%). The least commonly consumed fermented foods reported within the survey were sauerkraut (32%), acidophilus milk (3%), sake (7%), natto (3%), enjera (2%), and sujuk sausage (2%) from each food category respectively.

Table 3. Consumption frequency (%) of fermented food categories reported by university students (n = 328)

Products	Daily	A few times/week	A few times/month	A few times/year	Never	Missing
Fruits and vegetables	8	30	44	10	7	1
Dairy and alternatives	18	46	25	5	6	0
Beverages	1	17	49	20	12	1
Soybean	3	10	27	23	38	1
Grains	6	22	44	16	11	1
Meats	2	11	35	19	32	0

Enrollment in a Food and Nutrition program was associated with a greater likelihood of consuming fermented fruit and vegetables and consuming a greater variety of fermented fruit and vegetables (p = 0.02), in particular sauerkraut and kimchi. Both groups consumed pickles, olives, and apple cider vinegar in similar proportions. However, the frequency of consumption was comparable between groups with most participants reporting consumption a few times per month (30%) or a few times per year (44%). Respondent's awareness of health benefits associated with consumption of fermented fruits and vegetables was not associated with an increased likelihood of consumption ($p > 0.05$).

Results for consumption of fermented dairy products did not reveal a meaningful difference in the types of fermented dairy products consumed or frequency of consumption of these products between groups. The Food and Nutrition students and Non-Food and Nutrition students reported consuming fermented dairy products a few times per month or year, 45% and 25% respectively. Fermented dairy food products included in this study were yogurt, acidophilus milk, kefir, soft cheese, and fermented nut-based cheese. There was also no association between the awareness of health benefits provided by consuming fermented dairy products and increased consumption ($p > 0.05$).

The groups also had similar consumption patterns of fermented beverages and frequency of consumption of Kombucha, fermented juice, wine, beer, or sake. Respondents reported consuming these types of beverages monthly (16%) and a few times per year (51%). There was also no association between increased consumption of fermented beverages and the perception of their positive health effects.

Types of fermented soybean products consumed between groups of products, such as miso, tempeh, natto, or fermented soy milk, were similar. However, differences in the frequency of consumption of fermented soybean products existed between groups. Food and Nutrition students were more likely to consume fermented soy products a few times per year, while a greater portion of the Non-Food and Nutrition group reported consuming these types of foods daily ($p = 0.002$). Awareness of a positive impact on health with regular consumption of fermented soy increased the likelihood of consumption in the Food and Nutrition group ($p = 0.0086$).

No significant difference was observed between the groups and the type of fermented grain products consumed for sourdough bread, soy sauce, enjera, or fermented cereals. Differences were reported in the pattern of consumption between groups with Food and Nutrition students consuming these foods less frequently on a yearly basis compared to Non-Food and Nutrition group consumption on a monthly basis ($p = 0.02$). The Food and Nutrition group would consider increasing their frequency of consumption if they were aware of the health benefits of consuming fermented grain products ($p = 0.02$).

The types of meat products consumed between groups were similar for salami, chorizo, Sujuck, pickled herring, and Iberian ham. Although Food and Nutrition students consumed these foods more frequently on a daily basis, Non-Food and Nutrition students were more likely to consume these foods on a yearly basis ($p = 0.017$). Food and Nutrition students were also more willing to increase their consumption of fermented meats if they were aware of an associated benefit ($p = 0.017$) compared to the Non-Food and Nutrition participants.

Most participants cited enjoyment of fermented foods, improved digestive health, and increased nutritional value as reasons for consuming fermented foods. Four percent of respondents do not consume fermented foods.

Discussion

Nutrition knowledge is a key factor in an individual's decision to consume fermented foods [21]. Our research findings support this, demonstrating that individuals with a background in Food and Nutrition were more likely to report awareness of the health benefits associated with fermented foods. These benefits may include improvements in digestive health, nutrient bioavailability, and potential cognitive benefits. These outcomes align with existing literature, which shows that higher levels of nutritional literacy correlate with increased consumption of health-promoting foods [22]. Other reasons individuals consume fermented foods are for enjoyment, primarily their unique texture and flavors. However, taste preferences can also act as a barrier, particularly for individuals unaccustomed to the sour, umami, or effervescent profiles characteristic of fermented foods. Cultural familiarity plays a substantial role here: foods such as pickles, olives, and apple cider vinegar are more commonly integrated into Western diets, whereas products like kimchi and sauerkraut are typically associated with specific cultural traditions [10]. This could explain the greater reported consumption of the former group among both Food and Nutrition and Non-Food and Nutrition students.

Interestingly, no significant differences were observed between student groups in their consumption of fermented dairy products. This suggests that such products may be normalized within the general food environment, likely due to the marketing and widespread availability in North America. Yogurt, kefir, and other fermented dairy products are often positioned as probiotic-rich "functional foods" [11]. However, it is important to acknowledge that not all dairy products retain viable probiotic cultures in amounts sufficient to confer health benefits. This potential misconception may inflate the perceived nutritional value of these products among consumers, regardless of educational background.

Limited consumption of fermented beverages may be related to their relatively new presence within the market for products such as Kombucha and fermented juice. These products also have a distinctive taste which may not be appealing to some consumers. Whereas fermented beverages such as wine and beer have been prevalent within the North American market for decades. However, alcohol content in wine and

beer may deter individuals from consuming these products frequently resulting in consumption a few times per month or year.

Low intake of certain fermented products particularly meats and grains was notable. Several plausible explanations exist such as health concerns surrounding biogenic amines and nitrosating agents in fermented meat products that have been highlighted in prior studies [23]. These compounds are associated with an increased risk of carcinogenesis, which may prompt health-conscious individuals to avoid or limit such foods. Religious dietary restrictions further influence these choices, particularly regarding meat and alcohol-containing ferments. Finally, strong sensory characteristics such as pungency or unfamiliar textures can pose significant psychological and cultural barriers to adoption [24].

Moreover, traditional fermented foods such as natto, enjera, and certain sour porridges, which are nutrient-rich and central to diets in many non-Western countries, are often underrepresented in the North American food landscape. Their limited availability and cultural specificity may contribute to lower consumption levels, particularly among individuals lacking exposure or familiarity with global cuisines [15].

Conclusion

This study highlights the various factors that influence the consumption of fermented foods, including nutritional awareness, cultural familiarity, sensory preferences, and health beliefs. By synthesizing our findings with existing literature, it becomes clear that increasing exposure to fermented foods, enhancing product accessibility, and providing clearer information on their functional benefits could result in broader adoption, especially for lesser-known products. Notably, enrollment in a Food and Nutrition program was linked to greater knowledge and increased consumption of fermented foods. A greater understanding of the health benefits of fermented foods, coupled with their availability, appears to enhance the likelihood of their consumption. Public education initiatives targeted at individuals who could benefit from fermented foods may encourage them to incorporate such products into their diets. Further research is needed to explore whether the patterns of knowledge and consumption observed in this study are reflective of broader trends within the general population.

Limitations

The limitations of this study include the small sample size which consisted predominantly of female undergraduate students. Although participants represented various academic disciplines, approximately half were enrolled in Food and Nutrition programs across all four years, which may have introduced bias due to their prior knowledge or interest in the subject. This background could influence their food purchasing behaviors, particularly for those responsible for shopping for themselves or their households. Additionally, the fermented food categories included in the survey were derived from commonly consumed items across various cultures and regions. However, foods specific to an individual's dietary habits may not have been fully captured by the options provided. To mitigate this, each category included a fill-in-the-blank option, allowing respondents to specify alternative fermented foods.

Abbreviations

LAB: lactic acid bacteria

Declarations

Author contributions

SH: Conceptualization, Resources, Software, Formal analysis, Supervision, Validation, Investigation, Methodology, Writing—original draft, Writing—review & editing. LA: Conceptualization, Resources, Methodology, Validation, Investigation, Writing—review & editing.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

This study received approval from the Western Research Ethics Board (Project ID: 114997).

Consent to participate

Consent from all participants was obtained.

Consent to publication

Not applicable.

Availability of data and materials

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

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