Survey of safe and hygienic practices among Slovenian sauerkraut growers

Mojca Jevšnik*a, Valentina Hlebecb, Peter Rasporc,*

a College of Health Studies, University of Ljubljana, Poljanska 25a, SI-1000 Ljubljana, Slovenia
b University of Ljubljana, Faculty of Social Sciences, Kardeljeva ploščad 5, SI-1000 Ljubljana, Slovenia
c Chair of Biotechnology, Department of Food Science and Technology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia

A R T I C L E   I N F O

Article history:
Received 7 December 2007
Accepted 30 December 2008

Keywords:
Food safety
HACCP
Sauerkraut
Growing
Food handlers
Production
Qualitative and quantitative methods

A B S T R A C T

Food safety demands calls for new approaches to better understand the safe and hygienic practices of specific sectors in the food supply chain. In the present study, sauerkraut growers were investigated to explore their understanding of food safety and hygiene practices. A combination of quantitative (questionnaire prepared for the study) and qualitative (ten in-depth interviews) methods was used in the study so that topics could be discussed more completely and in greater depth. The results indicated that sauerkraut growers possess a rather good level of knowledge concerning food safety, although some gaps were discovered (e.g., record keeping and the feeling that recording data was an unnecessary burden, inadequate acquaintance with health status requirements, insufficient knowledge of the cabbage production process of food safety professionals, etc.). Some differences were found when comparing the results of the qualitative and quantitative studies. The qualitative analysis highlighted some contradictions (e.g., an attitude toward the production process: “We do not need the HACCP system”; a feeling concerning product safety: “Why the need for data recording?”) and differences between the sauerkraut growers and a professional understanding of good practice guidelines for sauerkraut production. All other determinations concerning food safety knowledge and practices are presented and discussed. The findings can be used as a guide for reorganizing current education programs aimed to improve safe and hygiene practices at the farm level.

1. Introduction

The history of food is interdisciplinary in nature and is a subject that is well studied. Food represents a large source of inspiration for culture, technology, nutrition and the well-being of humans (Raspor, 2006). Vegetables play an important role in human nutrition and health by providing minerals, micronutrients, vitamins, antioxidants, phytosterols and dietary fibres (Wennberg, Ekvall, Olsson, & Nyman, 2006). Cabbage and cabbage products are interesting from both marketing and dietary points of view because cabbage has many beneficial effects on health. From a traditional point of view, cabbage in the form of sauerkraut is one of the best known traditional foods. Traditional foods are an expression of culture, history and lifestyle (Trichopoulou, Soukara, & Vasilopoulou, 2007). World cabbage production amounts to approximately 55 million tons per year. Half of the quantity is produced in the Near East, with the biggest producer being China (Zhu & Zhou, 2001). In Slovenia, white cabbage (C1635) production amounted to 26050 tons (32.4 tons of harvest per hectare) in 2006 (Statistical Office of the Republic of Slovenia, 2007).

Since raw vegetables have a high microbial load and cannot be pasteurized without compromising product quality, most vegetable fermentations occur as a consequence of providing growth conditions (such as salt) that favour lactic acid bacteria (Caplice & Fitzgerald, 1999). Food fermentation is the oldest “biotechnology”. It covers a wide range of microbial and enzymatic processing of food and ingredients to achieve desirable characteristics such as prolonged shelf-life, improved safety, attractive flavour, nutritional enrichment, and promotion of health (Giraffa, 2004). A variety of fermented foods are produced in both industrialized and developing countries using this technology at the household level, in small-scale food industries, and in large commercial enterprises (Motarjemi, 2002). The majority of small-scale fermentation in developing countries, and even some industrial processes such as sauerkraut fermentation, is still conducted as a spontaneous process which is neither predictable nor controllable. When the yield is unstable, and where the desired microorganisms might not grow or the growth of pathogenic microorganisms might also occur, a controlled fermentation is used (Giraffa, 2004).

Food safety is the responsibility of food business operators (EU, 2004). Food safety legislation stipulates requirements and measures for the assurance of safety of food along the food supply chain. The appreciation of the importance of Quality Assurance Systems such as Good Agricultural Practices (GAPs) has been
increasing (Da Cruz, Cenci, & Antun Maia, 2006). GAP is defined as general practices designed to reduce microbial food safety hazards in the cultivation, harvesting, sorting, packing and storage operations for fresh fruits and vegetables, and should be developed in a stepwise manner based on the risk associated with individual fruits and vegetables and the scientific data available (De Rower, 1998; Da Cruz et al., 2006; Pabrua, 1999; Raspor, 2007). Like the Good Manufacturing Practices (GMP) and Good Hygiene Practice (GHP), the GAP programme is a pre-requisite for the implementation of the HACCP system at the field level. However, guides for good practices should encourage the use of appropriate hygiene practices at the farm level (EU, 2004). In sauerkraut production, it is necessary to follow GAP and GHP guidelines (Anon., 2004). GHP consists of practical procedures and processes that return the processing environment to its original condition (disinfection or sanitation programmes), maintain buildings and equipment in efficient operation (maintenance programme), and control cross-contamination during manufacture (usually related to people, surfaces, the air and the segregation of raw and processed products) (Raspor, 2007). Food hazards present at the level of primary production should be identified and adequately controlled in order to comply with the objectives of the EU Regulation.

In Slovenia, the GAP programme is a countrywide initiative that includes aspects such as effective monitoring of pesticide residues and the implementation and control of strict hygiene and food safety regulations (Anon., 2007). Hazard Analysis and Critical Control Point (HACC) studies of some fermented products have demonstrated that some fermented foods may pose a safety risk depending on the process and the hygienic conditions present during preparation. Fermented foods must therefore be studied in relation to HACC principles, and small-scale food industries and households must be advised of the critical control points of fermentation processes and the control measures applicable at these points (Motarjem, 2002). Slovenian draft guidelines of GHP for crop production recommended temperature and pH control as critical control points during acidification (Anon., 2007).

Although the strict application of HACC at the primary production level is not always practical, it is possible to use the HACC approach to develop a risk-based and product-specific GAP. However, authors of technical and scientific articles have recently started to question the efficiency of HACC, especially in SMEs (Azanza & Zamora-Luna, 2005; Henroid & Sneed, 2004; Taylor & Taylor, 2004a, 2004b; Vela & Fernández, 2003), and have searched for potential causes of the system's failed efficiency. Several studies have identified barriers to HACC implementation in the foodservice and retail industries (Gilling, Taylor, Kane, & Taylor, 2001; Jevšnik, Bauer, Zore, & Raspor, 2007; Jevšnik, Hlbec, & Raspor, 2008; Strohbehn, Gilmore, & Sneed, 2004; Sun & Ockerman, 2005; Taylor, 2001; Von Holy, 2004; Wai, 2004). Von Holy (2004) indicated that lack of financial and human resources are fundamental barriers to HACC implementation in small food businesses. Meta-analysis of barriers during HACC implementation has shown that among twenty-one investigated elements, seven elements (training, human resources, planning, knowledge and competence, documentation, resources, management commitment) represent almost 50% (47.8%) of all identified barriers (Jevšnik, Hlbec, & Raspor, 2006). Therefore, in the food safety area it is very important that all parts of the chain know, understand and fulfill their responsibilities. The individual is an important part of understanding an attitude towards food safety (Jevšnik et al., 2007). For this purpose, research with a group of food handlers, which are at the same time growers and producers, was carried out. The objectives of the study were to determine the perception and awareness of Slovenian sauerkraut growers regarding food safety hazards and hygiene practice in sauerkraut production. The goal was to understand the nature of good practices, the HACC system and hazards comprehension, and to determine how food safety is interpreted, handled and communicated by participants in everyday practice.

2. Materials and methods

2.1. Questionnaire

2.1.1. Questionnaire design

A self-administrable questionnaire was developed for this study comprising 20 multiple-choice questions each with four, five or six possible answers, including “do not know” and “other”, for the purpose of minimizing the possibility of selecting the correct answer by chance. In addition, six questions were related to the demographic characteristics of respondents (educational level, personal income, type of settlement, gender, age, and number of years in a food business). The questions were designed and structured in four groups: (1) sauerkraut growers’ acquaintance with GAP, GHP and the HACC system; (2) integration of the HACC system and good practices in the production process; (3) principles of GHP and GAP; and (4) comprehension of hazards during the production process.

Respondents completing the questionnaire remained anonymous. The questionnaire was pilot tested by 10 participants during April 2006, resulting in minor modifications to the wording of questions. Each questionnaire took approximately 10 min to complete. The study was conducted from June to September 2006.

The questionnaires were sent to all the registered sauerkraut growers in Slovenia (n = 112). Sample information (number of sauerkraut growers and their addresses) was collected using the database of the Chamber of Agriculture and Forestry of the Republic of Slovenia. Questionnaires, details explaining the survey, and a short guide for questionnaire fulfilment were sent by mail to the sauerkraut growers. Each envelope included an empty envelope with a postage stamp and a return address so that completed questionnaires could be returned. After the first dispatch, 21 (18.75%) completed questionnaires were returned. We sent a second letter thanking all of the participants and kindly asked those who hadn’t completed the questionnaire to complete it and send it back. After the second dispatch, we received an additional 14 (12.5%) completed questionnaires. A total of 35 (31.25%) completed questionnaires were received.

2.1.2. Statistical analysis

The questionnaire responses were analyzed using SPSS version 13.0 software. Mean responses with standard deviation and percentages of responses in each category were calculated and are presented in tabular form. To examine the relationship between the variables, cross tabulations and the χ2 test, Pearson correlation coefficient, independent sample t-test and ANOVA were used.

2.2. In-depth interviews

An empirical grounding was important in this study because an exploration of good agricultural and hygiene practices, together with food safety perceptions, will form the basis for theoretical considerations. In-depth personal interviews were chosen due to the sensitivity and complexity of the subject discussed. The interviews with the sauerkraut growers and their supervisors were qualitatively analysed, using the grounded theory method. Grounded theory produces theoretical models of individuals’ perspectives of a given phenomenon and the strategies they use to resolve or cope with the problem in a distinct and bounded context (Glaser & Strauss, 1967; Strauss, 1996; Stave & Törner, 2007). The
methodology used in-depth interviews to create an open and trusting atmosphere in an effort to elicit more in-depth results (Hollway & Jefferson, 2003; Gilling et al., 2001).

The in-depth interviews with sauerkraut growers were carried out from November 2006 to February 2007. Information regarding the number of sauerkraut growers and their addresses was collected using the database of the Chamber of Agriculture and Forestry of the Republic of Slovenia. Among 112 registered sauerkraut growers, 28 were randomly selected and invited over the phone to participate in the research. Ten of the 28 invited growers consented to participate.

The interview guide covered the following topics:

- Factors responsible for the safety of the final product, from plant to sauerkraut.
- Conditions related to food safety hazards.

During the interview, factors that have affected the safety of the final product (sauerkraut) acted as a concrete event through which the person could disclose his/her own perceptions of discussed factors. The interview started with questions concerning the place, date and time of the accident in order to assist recall.

The first open thematic question: "Tell me as much as you can about the importance of the sauerkraut production process, and about the factors that could affect its safety." Follow-up questions were posed to complement and facilitate the dialogue. Second thematic question: "Could you please explain when sauerkraut is considered safe for a consumer?" Third thematic question: "Who in your opinion is responsible for informing farmers about novelties in regulations/guidelines in the field of food safety?" The dialogue now centred around direct and indirect factors affecting responsibility for the safety of the final product during the production process and focusing on the good practices, but at all times avoided the issue of blame. The interview ended with a question on whether the interviewee had something to add. Efforts were made to create trust, since issues of guilt and failure may easily arise.

Interviews lasted an average of 20 min. An eventual connection between the type of farming and understanding of food safety was determined by the interviews. In order to maintain the anonymity of respondents, they were marked according to the type of farming (C: conventional farming; I: integrated farming).

Interviews were recorded using a dictaphone and later transcribed. Transcripts of the interviews were analyzed by coding the statements of the respondents using identified notions. The notions were gathered into topic categories (Glaser & Strauss, 1967; Strauss, 1996; Hollway & Jefferson, 2003). The validity is justified by triangulation. Three researchers with different disciplinary basic knowledge and different experiences in research were included in the analysis and interpretation process.

3. Results and discussion

3.1. Questionnaire

3.1.1. Sample characteristics

Of the 35 farmers taking part in the research, 45.7% classified their farming as an integrated type and 54.3% as a conventional type. None of the respondents classified their farming type as an ecological type. 77.1% of the respondents (40% of farmers with integrated farming and 37% of conventional farmers) possess a certificate of qualification. 17.1% of respondents with integrated farming possess no certificate of qualification for their business. Most of the respondents (68.6%) are male. Details of the educational level of respondents showed that almost a third (31.4%) completed vocational school, secondary school (25.7%), primary school (22.8%), or had finished high school or more (11.4%). 77.1% of the respondents farmed in villages and 22.9% in suburbs. Most of the sauerkraut growers (88.6%) use their own heads of cabbage for acidification, while 11.4% use both their own and those that are bought.

3.1.2. Qualifications of sauerkraut growers and their familiarity with food safety demands (GAP, GHP and HACCP)

The majority of the 35 respondents are familiar with the principles of GAP (94.3%), GHP (94.3%) and the HACCP system (97.1%). The respondents obtained most of their information regarding GAP and GHP from the support service of the Chamber of Agriculture and Forestry of the Republic of Slovenia. 54.3% of the respondents obtained information about the HACCP system from the support services and 40% from the inspectors (Table 1). Media represent a smaller part of the information sources, especially for GHP and the HACCP system.

Almost half of the respondents (45.7%) are familiar with the proper purpose of the good practice guidelines (to eliminate or reduce hazards) (Table 2). The next most popular opinions view good practice guidelines as exact working instructions for producers (20%) or as a basis for pointing out mistakes in the production process (8.6%).

3.1.3. Following good practices in sauerkraut production

The majority of the respondents believe that the principles of GAP should be followed in sauerkraut production (Table 3). A small part of the respondents thinks that keeping records of sowing and planting of cabbage is unnecessary (14.3%), or expressed a similar opinion concerning product gathering (11.4%). The period of sowing and planting should be selected carefully so that it does not increase the growth of harmful microorganisms. Therefore, it is very important to record the time of sowing and planting because it is an assurance and proof of a proper timing.

The respondents are familiar with requirements regarding the use of phytopharmaceutical products. This finding was expected because regular training on this topic is obligatory. Existing legislation regarding plant health protection and phytopharmaceutical products, which is adjusted in accordance with EU legislation, should also be followed. Most of the respondents use phytopharmaceutical products to improve the quality of the product and increase the quantity. According to the respondents, the main reasons for the use of phytopharmaceutical products in cabbage growing include a better quality of the product (57.1%), a larger harvest (22.8%), a better resistance of plants (8.6%), and easier work (5.7%). Two of the 35 respondents stated that they did not use any of the mentioned products.

Records of acidification activity help to analyze activities performed during production and offer a starting point for the continuous improvement of planning. Records prove the quality and safety of a product in all the production phases. Following GAP principles increases the value of agricultural products (Da Cruz et al., 2006), which influences a consumer’s trust in the quality of home-grown products. The respondents attached great importance to record keeping in the production of sauerkraut. The highest importance was placed on record keeping of personnel health status (mean value 4.2) and cleaning (mean value 4.0). Less importance was attached to records of the acidification process (mean value 3.9) (Table 4).

3.1.4. Hazards during production and the safety of the final product

Hansen (2002) pointed out that the main problems to solve (or to improve) are still the old ones: reduce spoilage, avoid foodborne diseases, and preserve or develop an attractive flavour, taste and appearance of the food. Lactic acid bacteria have much to offer within food preservation and flavour generation.
The opinions of respondents concerning the safety of the final sauerkraut product reflect an appreciation of the importance of both hygiene and technological factors (Table 5), although the perceived level of importance is greater in women \( (p < 0.05) \) than men. Sauerkraut growers who possess a certificate of qualification placed higher importance on some of the production stages \( (p < 0.05) \) than good hygiene practice principles, which had the lowest the mean value \( (3.8) \). The latter was more important to sauerkraut growers who had finished primary school or less than those who possessed a post-secondary education \( (p < 0.05) \). Women and respondents with a certificate of qualification placed higher importance on some of the production stages \( (p < 0.05) \). The respondents regarded all production phases as important for the safety of the final product (Table 6) since all mean values were above 4.8, except for the gathering of the heads of cabbage, which had the lowest the mean value \( (3.8) \). The latter was more important to sauerkraut growers who had finished primary school or less than those who possessed a post-secondary education \( (p < 0.05) \). Women and respondents with a certificate of qualification placed higher importance on some of the production stages \( (p < 0.05) \).

Respondents are not sufficiently educated concerning the impact of the health status of persons handling food (Table 7). They are aware that persons with diarrhea and hand wounds should not be allowed to handle the food because of the high risk of infections. But their answers were more varied when asked about other...
symptoms (e.g., coughing, fever, etc.). Their knowledge of possible corrective action for cuts or coughing (e.g., proper wound care, a protective mask when coughing) is also poor.

3.2. In-depth interviews

The results of the qualitative study are supported by the responses recorded by the interviewers, which are clearly marked.\footnote{A mark (I, C) represents a type of farming (I – integrated farming, C – conventional farmers), while a number represents a running number of interviews (from 1 to 10).}

Ten interviews with cabbage growers, who are also sauerkraut producers, were carried out. Half of them were involved with integrated farming (I), and the others with conventional farming (C).

During transcription, the initial answers to the question “What is important for the safety of the final product from the plant to sauerkraut?” formed the first general impressions of the respondents’ food safety opinions. The results indicated that the respondents rarely comprehend food safety separately, but view it in different combinations with other facets, e.g., GHP importance and protection from pesticides, or work awareness and following written rules, or higher income and safety for consumers, or system HACCP and work awareness, etc. This aspect is the most obvious in the following statement:

I (VIII): … if anything goes wrong, it can be seen immediately. The cabbage changes colour, it is soft. I don’t know if anything else can be wrong with the cabbage. It’s common talk that cabbage is very good for your health. And because it is sour, I think that this is already some kind of protection and it is not problematic for a consumer.

Five topics were identified following text analysis of respondents’ answers during interviews: the healing power of cabbage, hygiene, the technological process, harmful factors, and other factors influencing the safety of the final product (see Scheme 1). These topics were obtained after pinpointing topics in statements that were combined.

3.2.1. Cabbage as a healing food

The majority of respondents believe cabbage is highly effective as a healing food because of its properties, and that it cannot be dangerous for a consumer.

I (VIII): … it’s common talk that cabbage is very good for your health. And because it is sour, I think that this is already some kind of protection and it is not problematic for a consumer.

The respect for traditional sauerkraut making as practised by their ancestors was especially marked.

C (IV): … it has been already done by our forefathers and they already knew the healing power of cabbage.

3.2.2. Hygiene

All the production phases in cabbage acidification are equally important to the respondents. They pointed out that none of the phases must be left undone. The following hygiene principles during acidification were highlighted as very important factors.

General hygiene:

C (IV): … hygiene is very important…
I (VI): … one has to follow hygienic rules.

Traditional foods and dietary patterns may have potential health properties that have been tested over generations (Trichopoulos et al., 2007).

3.2.3. Harmful factors

The respondents stressed that the type of growing, work awareness, and a strict following of working instructions are important for the safety of sauerkraut. They highlighted the danger of using too much pesticide. The importance of the latter is stressed to a greater degree by farmers involved in integrated farming.

I (VI): Nowadays it is most important that farmers strictly follow instructions for spraying the cabbage in fields.
I (VII): … if you don’t produce with heart and if you just spray and spray, the cabbage won’t be healthy.

Different pesticides (insecticides, fungicides and herbicides) are applied ineffectually to control insect pests and diseases of the spring cabbage. Vegetables are susceptible to insect and disease attacks, and pesticides are used widely. Pesticide residues could therefore affect the consumer’s health, especially when the plant product is freshly consumed (Zhang, Liu, & Hong, 2007). Virtually all chemicals can be shown to be dangerous at high doses, and this includes the thousands of natural chemicals that are consumed every day in food, particularly in fruits and vegetables (Trewavas, 2004). Sauerkraut growers are aware of the importance of following the instructions for spraying. The adoption of traditional sauerkraut production is a guarantee for the safety and quality of the final product. Respondents stressed the importance of hygiene and following directions for the use of plant protection products.

They dislike using citric acid for improving the quality and extending the date of durability of sauerkraut. The conventional farmers placed greater emphasis on the importance of natural cabbage salting, without the use of antibiotics or other additives.

C (IV): In shops additives are added to the cabbage so it lasts longer. And that, you see, is not safe for your health. Well, the records are probably OK, but our customers say they are satisfied with our cabbage because we add nothing. One lady said she had stomach-ache when she ate sauerkraut bought in a shop.

One of the respondents emphasized the importance of proper fertilization:

C (X): It is also very important that raw material is not fertilized too much by manure or nitrogen.

Other respondents pointed out that the location of a field and its proximity to main roads can influence the hazardous metal content in the head of cabbage.

I (IX): If I was a consumer, it would be most important to me where the cabbage was grown – in a city or in a village. You know, I attended a seminar where I heard about lead absorption in the heads of cabbage. And there is lots of lead on the roads.

I (VII): Cabbage is considered a medicine. That is why our ancestors were so healthy – they lived on sauerkraut and potatoes.

### Table 7

<table>
<thead>
<tr>
<th>Health criteria that influence food handling permission.</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>I do not know (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>... (n = 35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... has diarrhoea?</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
</tr>
<tr>
<td>... has high blood pressure?</td>
<td>82.9</td>
<td>11.4</td>
<td>5.7</td>
</tr>
<tr>
<td>... has a cold?</td>
<td>5.7</td>
<td>91.4</td>
<td>2.9</td>
</tr>
<tr>
<td>... has a toothache?</td>
<td>82.9</td>
<td>14.3</td>
<td>2.9</td>
</tr>
<tr>
<td>... coughs and wears a protective mask?</td>
<td>37.1</td>
<td>62.9</td>
<td>0.0</td>
</tr>
<tr>
<td>... has a fever?</td>
<td>17.1</td>
<td>82.9</td>
<td>0.0</td>
</tr>
<tr>
<td>... vomits?</td>
<td>2.9</td>
<td>97.1</td>
<td>0.0</td>
</tr>
<tr>
<td>... cuts himself?</td>
<td>5.7</td>
<td>94.3</td>
<td>0.0</td>
</tr>
<tr>
<td>... wears nail polish?</td>
<td>20.0</td>
<td>71.4</td>
<td>8.6</td>
</tr>
<tr>
<td>... is upset?</td>
<td>82.9</td>
<td>14.3</td>
<td>2.9</td>
</tr>
<tr>
<td>... has wounds on his hands?</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

1 A mark (I, C) represents a type of farming (I – integrated farming, C – conventional farmers), while a number represents a running number of interviews (from 1 to 10).
Personal hygiene:

I (V): … hygiene was always important, not only now that we have this HACCP. If one feels conscious, if one works with heart, then one won’t press the cabbage with dirty boots or cut the cabbage with a dirty grater, even if one is not familiar with HACCP.

I (VI): … I always put a plastic bag on my hand. So I never touch the cabbage with uncovered hands. When I change, I always take the bag off. When I sell I always wear a clean white apron.

Hygiene of basins:

C (II): … in order to have a good sauerkraut, basins must be clean.

I (VI): … one has to pay attention to the cleanliness of basins and all other accessories.

Cleaning of the heads of cabbage:

C (IV): It is important that the heads are really clean prior to slicing, so there are no snails or caterpillars or dirt. But if the cabbage is of top quality, then there’s no problem with that.

Conventional sauerkraut growers place greater stress on hygiene in general than other sauerkraut growers, including those involved in integrated farming. But a few contradictions appeared between the former and modern methods of acidification. The HACCP system requires a precise cleaning schedule, which was not required in the past. One of the respondents believes that stricter requirements do not always contribute to a better result:

C (X): … well, we wash all the basins with steam at 100 °C. We didn’t do that in the past and we still didn’t have any problems. As I said, everything is cleaned with steam, so all the cleaning is a hot one, and after slicing we put plastic foil on the top, the basin is closed immediately and weighed.

3.2.4. Technological process

Sauerkraut growers favour the traditional way of acidification, which includes changing the acidification method and regular organoleptic testing of the product. Traditional foods reflect cultural inheritance and have left their imprints on the respective dietary patterns, despite the fact that contemporary lifestyles do not encourage their preservation in our daily lives and customs (Trichopoulou et al., 2007). But the attitude and experiences of the sauerkraut growers are in contradiction with the guidelines, which rest on hazard analysis and corrective actions on critical points of the acidification process. Slovenian draft guidelines concerning good hygiene practice for crop production suggested that temperature and pH control were critical control points during acidification (Anon, 2007).

A number of foodborne hazards are capable of surviving the fermentation process (Motarjemi, 2002). Lactic acid bacteria are widely used in the production of fermented food, and they constitute the majority of the volume and value of commercial starter cultures. The primary activity of the culture in food fermentation is to convert carbohydrates to desired metabolites such as alcohol, acetic acid, lactic acid or CO2. Alcohol and organic acids are good natural preservatives, but they are also appreciated in their own right in the fermented product (Hansen, 2002). Caplice and Fitzgerald (1999) summarized the characteristics of lactic acid bacteria, which are generally mesophilic but can grow at temperatures as low as 5 °C or as high as 45 °C. Similarly, while the majority of strains grow at a pH of 4.0–4.5, some are active at pH 9.6 and others at pH 3.2; strains are generally weakly proteolytic and lipolytic and require preformed amino acids, purine and pyrimidine bases, and B vitamins for growth (Caplice & Fitzgerald, 1999). Enteropathogens, such as enterohaemorrhagic E. coli, show some patterns of acid resistance and may survive certain fermentation processes. In addition to being an agent for diarrhoeal diseases, food may also be a vehicle for chemical hazards, whether naturally present in the food (e.g., cyanide) or contaminating the food as a result of poor agricultural practices (e.g., pesticide residues) or environmental pollution (heavy metals, dioxins) (Motarjemi, 2002).

The respondents placed great importance on the proper technological acidification process. But their understanding differs from that maintained by officials. Darkening of rooms and basins was highlighted.

C (II): The acidification room must be dark. This is important.

C (IV): Well, the room must be dark; otherwise the sauerkraut is soft.

The proper salting method, which has an impact on quality rather than safety, was also highlighted.
C (I): The biggest problem that can occur in acidification is too much or not enough salt. If cabbage is salted too much the final product is too firm, and if there's not enough salt the sauerkraut is too soft.

I (VI): If I don't put enough salt on the cabbage, the sauerkraut spoils...

Maintaining an optimal temperature (18 °C) is important for the activity of lactic acid bacteria. In the first three weeks of acidification, many of the sauerkraut-specific aromas, acids and esters develop. That is why odour and taste defects are the result of improper lactic acid fermentation. In a draft concerning good hygiene practice guidelines for crop production, temperature was highlighted as the critical control point in the process of cabbage acidification. The importance of temperature as a key factor that influences the time and quality of sauerkraut production was pointed out by both conventional and integrated sauerkraut growers. But both groups stressed that temperature monitoring during acidification is not necessary. They explained this claim on the basis of favourable weather conditions: the acidification takes place during autumn when the temperature is not so high, and basins suitable for acidification are located in cold basements or in the ground. Above all, respondents highlighted the value of their own instinct and experiences regarding sauerkraut production, and the need for regular organoleptic testing.

C (III): If the temperature is higher, yeast starts to develop. But I don't measure the temperature because I have a feeling about it. Our rooms are good, so we don't have problems with the temperature.

Their answers to the additional question “When can you be sure that the sauerkraut is safe for a consumer?” were unified. They estimate the suitability of the sauerkraut using organoleptic parameters such as colour, smell, taste and firmness. If the product meets their criteria, which are based on traditional recipes and long-term experiences, then they can be certain that the sauerkraut is safe for a consumer.

C (II): ... well, that can be seen immediately. If the sauerkraut is dark, almost brown and soft... one can never sell such sauerkraut.

C (X): Sauerkraut must give off a pleasant scent when you open a basin. Once I opened a basin and the sauerkraut looked fine, but I knew something was wrong. And then it really started to change colour. I had to throw the whole basin away.

3.2.5. Other factors

Respondents were asked three additional questions: (1) How do you judge the importance of packaging for sauerkraut safety and the health status of people? (2) Could you explain when sauerkraut is considered safe for a consumer? (3) Who is responsible for informing farmers about novelties in the field of food safety?

The answers of respondents, when asked directly or through an additional question, acknowledged a concern regarding the health status of the food handlers, a packaging impact on the safety of the final product, the HACCP system, a responsibility for informing farmers about novelties concerning a particular subject, and the surveillance of food safety assurance.

The respondents link health status with the difficulty of performing work, and with possible infection of the product.

I (VI): ... to record if one is ill or not, makes no sense. If one is ill in one way or other, one can't work.

Most of the respondents think that an ill person is not able to perform work as hard as cabbage acidification, and that is why they do not link health status with safety of the final product. They regard health status merely in terms of the ability to work. Only one respondent, a conventional farmer, stressed its importance for consumer protection and that all working personnel need to be healthy.

C (IV): During acidification I've been ill only once. Then the work was performed by the others because I was not allowed. There was a risk I could infect somebody.

The respondents do not link the packaging of sauerkraut with safety hazards. It was only when asked the additional question “Could the packaging influence the safety of the sauerkraut?” that most expressed a belief that the packaging should be clean and made of a suitable material.

C (IV): Well, our basins are made of plastic, of a plastic specially made for cabbage acidification. The gentleman who sells the basins gave us a certificate for the plastic. Customers buy from us every day, so we put the sauerkraut in 2- or 3-litre bags. Some of the customers buy more sauerkraut, so for them we pack in pails made specially for sauerkraut.

The sauerkraut growers think that the final product is more important than packaging because they have to sell it to earn money. For economic reasons they sell the product in cheap packaging, such as plastic bags. They stressed that the customers prefer to buy smaller units, and that this is why they don't need to choose another kind of packaging.

C (I): We sell in ordinary plastic bags because we sell in a market hall. Since the sauerkraut is fresh and meant for instant consumption, we don't put it in pails.

I (V): A good product is sold even without pretty packaging. These days one does not eat the sauerkraut every day. When one buys it, one puts it in a pot immediately.

All the respondents are familiar with HACCP, but they don't believe in this system because the legislation requires that they implement it in their technological process. They regard the HACCP system as an additional burden, mainly because of the necessity of recording performed activities and as work for the inspectors. They believe the recording to be burdensome and unnecessary.

I (VIII): For us, the sauerkraut growers, it is not important to fill in the HACCP forms. We know exactly when to clean or when we sliced the cabbage. One doesn't forget that because one is then so busy. Writing is only additional work.

Only two of the respondents expressed a positive attitude towards record keeping. A conventional farmer thinks that above all it is most important to organize the work well, and then records are no problem at all.

C (I): There's no problem in recording and writing. If one has everything in order and rooms are prepared according to HACCP, then that's the minor problem.

One of the integrated farmers stressed that there were few advantages and many weaknesses of record keeping. This experienced farmer recalled his daily activities and finds written records senseless.

I (IX): ... well, some of them are really clever ones. To record the time of slicing ... Usually one remembers that ... To write down when one sprays to know the abstinence period, makes sense. But to write down if one is healthy makes no sense. If one is ill, one can't work. And to write down if one washes hands is senseless as well. I wash mine 100 times a day. I do it automatically. A lot of that stuff is unnecessary. Otherwise HACCP is the same as we've done in the past.
The respondents believe that the HACCP system brought nothing new or improved to the production process because all the necessary procedures were already implemented in the past, before HACCP became obligatory. That is why they don't see any sense in this system. They think that attitude and working with a sense of pleasure are important.

C (III): No HACCP will help if one does not have a feeling and if one doesn't work with pleasure.

Dissatisfaction with inspectors was expressed because some inspectors are only satisfied when they see formal documentation indicating that everything appears to be in accordance with the HACCP system. They are not interested in the actual state or conditions of production.

C (II): Inspectors are only interested in a paper. As long as everything is in writing, everything is OK. The sauerkraut was good even before HACCP.

The respondents are disappointed with the Chamber of Agriculture and Forestry of the Republic of Slovenia and inspectorates in regard to keeping farmers and sauerkraut growers informed. They are left to their own resources, in spite of paying membership fees to the Chamber of Agriculture and Forestry.

C (III): I don’t know who’s responsible. We pay fees, but the Chamber of Agriculture and Forestry doesn’t do anything. There are some seminars, but mainly about the spraying. There are the strictest requirements there. Our parents taught us how to make the sauerkraut and they were the best teachers. For work you have to have a good feeling and one has to work with pleasure.

C (I): The inspectors visit us at least five times a year; all kinds of inspectors, health, agricultural and market inspectors. Each of them wants to have something different. But they can’t teach us because we know more than them.

They are informed through the media and through consultation with other sauerkraut growers.

I (VIII): I don’t know who’s responsible, … probably us. Sometimes we consult with one another, other times one hears something from the inspectors.

They get little information from inspectors when they visit, and say that the visits by the inspectors are frequent. They stressed that the quality and amount of information depends on the individual inspector, and above all on their education in the technology field.

I (IX): … these days everybody knows everything. All of them are so clever, but they don’t know much about the cabbage. Sometimes I have to teach the inspectors. Well, they haven’t made any sauerkraut so far, so they can’t know, even if they are experts. The act of making is something different. Everything depends on us. We don’t get much help. That is something we expected from the beginning.

4. Conclusion

Almost half of the respondents are familiar with the main purpose of good practice guidelines, in contrast to their total familiarity with requirements regarding the use of phytopharmaceutical products. The majority believe that the principles of GAP should be followed in sauerkraut production. Only a small part of respondents believes that record keeping during the sowing and planting of cabbage is unnecessary. Respondents regard hygiene and technological factors as important for the safety of sauerkraut. Sauerkraut growers who possess a certificate of qualification placed less importance on personal hygiene principles than those who do not have such a certificate. The results stressed the importance of training topics, which according to respondents are more oriented towards the technology of sauerkraut production than good hygiene practice principles, with the result that respondents are not sufficiently educated about the impact of the health status of persons handling food. The respondents regarded all phases of the sauerkraut production process to be important for the safety of the final product, although less importance was attached to the phase involving the gathering of cabbage heads. This phase was more important to sauerkraut growers who had finished primary school or less than those who had a post-secondary education. It is interesting to note that women and respondents with a certificate of qualification placed higher importance on some of the production stages than other respondents.

A combination of quantitative and qualitative methods was used in this study so that topics could be discussed more completely and in greater depth. A benefit of using qualitative methods involves accessing the richness of the experiences of participants and their comprehension of studied phenomenon. It enables inclusion of individual experiences, which cannot be obtained by a quantitative methodology (Strauss, 1996).

An analysis of the quantitative results revealed that recording during the process of acidification is very important for the sauerkraut growers. The influence of HACCP training is evident because the importance of keeping records is highlighted in those training sessions. An analysis of the qualitative results showed that filling in forms is regarded by producers as additional work, which in their opinion is senseless. They believe it is necessary only because it satisfies the inspectors.

The results of both the quantitative and qualitative research are equal regarding the importance of temperature for the acidification process. But the qualitative results revealed that sauerkraut growers do not regard temperature as a problem because acidification takes place during autumn. They stressed that recording temperature makes no sense because the organoleptic testing shows the quality of the sauerkraut.

The quantitative and qualitative results showed that phytopharmaceutical product usage is prompted by a desire for a quality product and higher quantity. The respondents are aware that use of phytopharmaceutical products is dangerous for people and the environment. The qualitative analysis pointed out a desire to be informed because instructions for the preparation of pesticide solutions are considered too complicated.

One of the key characteristics of the quantitative and qualitative research is that hygiene is regarded by farmers as both important and a necessary basis for the production of a quality and safe product. The quantitative analysis shows that sauerkraut growers are not sufficiently familiar with illnesses that can threaten the safety of the product and the health of a consumer. An analysis of the answers provided by respondents revealed that they view health status in connection with hard work rather than the possibility of infections.

The quantitative results show that respondents possess a rather good level of knowledge. The qualitative research highlighted a feeling of disappointment with the inspectorates. Respondents believe that the quantity and quality of information depends on the level of responsibility of the person and his knowledge, which in many cases is inadequate.

Some interesting findings were made when comparing the results of the qualitative and quantitative studies. The quantitative study indicated that sauerkraut growers possess a rather good level of knowledge and practical expertise of the most important hygiene and food safety action points, which could not be confirmed with the qualitative study. The qualitative analysis pointed out some contradictions (e.g., individual attitude toward the produc-
tion process/HACCP system, an individual feeling concerning product safety/the need to keep records) and differences between the layperson (sauerkraut growers) and a professional comprehension of hazards (good practice guidelines for sauerkraut production) during sauerkraut production. These findings lead to a better understanding of the food safety and hygiene comprehension of individuals. Food safety experts should be aware that all food safety participants need a complex and individual discussion. Individual hygiene awareness is the most important tool for food safety assurance, and this is why the individual must be discussed on equal terms with all the other hazards. The findings of this study can be used to modify current education programs aimed to improve food safety at the level of the farm.

5. Limitations and future research

In this study, only 35 of the 112 sauerkraut growers registered in Slovenia responded to the questionnaire. Therefore, it may not be appropriate to generalize the results. To attain better insight in discussing problems, ten in-depth interviews were also performed. There are a lot of possibilities for future research in the field of primary production (in-depth interviews with farmers in different fields of farming, growing, etc.). The understanding of safety by consumers at the farm level is also of interest for further research.

Acknowledgments

Mojca Ješnik would like to acknowledge the College of Health Studies, University of Ljubljana for covering part of the material costs required for this study. Mojca Ješnik would also like to express her gratitude to Ms. Branka Strah for her help with the in-depth interviews, as well as all sauerkraut growers who gave their time to participate in this study.

References


