



Acceptability of Edible Food Packaging in Slovakia: A Case Study on Young Generation

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The increasing problem of plastic pollution from food packaging created a new market potential for inventing environmental-friendly packaging in the food market including edible food packaging. The main objective of the study was to identify attitudes and perceptions of young people toward edible food packaging. Primary research was conducted via a questionnaire survey. The research sample involved 22 respondents between 19 and 30 years from Slovakia. A questionnaire survey was interconnected with sensory analysis where respondents tested 23 samples of edible food packaging. The results showed that consumers perceive as the most important aspect of food packaging the possibilities of their recycling, followed by the protective function and ecological aspect, while the least important aspect was the design of the packaging. The best rating based on the taste was obtained by sample no. 22 (*Mentha × Piperita*) while the worst rating was obtained by sample no. 3 (*Zingiber officinale*). The majority of tested edible food packaging had an indifferent taste.

Keywords: acceptability, edible packaging, sensory testing, consumer perception, young segment

INTRODUCTION

Plastics are inexpensive and durable materials that are used in a variety of products and current levels of their usage affect many environmental problems because they are usually discarded after consumption of food. The main part of plastic produced every year is used for the manufacture of disposable packaging or other short-lived products which are disposed of within 1 year of manufacture. If plastics waste is recycled, we might say that it can reduce landfills. However, just a little amount is only recovered through recycling, because if they are not recycled, they are dumped in landfills where they last forever or they are burnt for energy recovery which producing harmful gasses causing air pollution (Hopewell et al., 2009). Packaging is an essential element of response to address key challenges of sustainable food consumption on the international scene, which is clearly about minimizing the environmental footprint of packed food (Guillard et al., 2018). Food industries try to find a suitable alternative for plastic to minimize their usage in food packaging and they consider edible packaging to be one of the best options in this possibility (Milani and Tirgarian, 2020).

We can consider edible food packaging as a thin layer formed on the food surface, which can be eaten as an integral part of food products, and if we ate them, they do not produce pollution and waste (Jeevahan and Chandrasekaran, 2019). The edible coating is usually applied directly to the surface of the product by dipping or spraying in liquid form (Hassan et al., 2018). They are influenced by several factors, for example, their formulation, additive properties, production technology, and solvent. We need to produce such edible food packaging which is increased in the request for coating and film quality, high product safety, storage period (Beikzadeh et al., 2020). Although it is unexpected that coating and single films completely replaced packaging materials, they can be used to prolong the stability of food by reducing the exchange of moisture, lipids, volatiles, and gases between food and the environment (Tian and Bilal, 2020).

Traditional food packaging materials are plastics based on petroleum such as polypropylene, polyethylene, and polystyrene, and they are widely used due to their relatively lightweight, shape properties, and lower weight than other materials (Allegra et al., 2017; Vasile, 2018; Ahmadi et al., 2020). Scientists have been looking for promising alternatives, because of environmental pollution (Zhang et al., 2020). Some degradable films composed of biocompatible macromolecules with good film-forming properties, for example, polysaccharides and proteins seem to be promising alternatives for plastic packaging (Kunwar et al., 2016; Jeevahan and Chandrasekaran, 2019). Nanotechnology has proven to be a promising method to ensure the use of bioactive substances, antimicrobials, vitamins, antioxidants, and nutrients to increase the functionality of edible packaging (Trajkovska Petkoska et al., 2020).

The aim of this study was to identify attitudes and perceptions of young people toward edible food packaging.

MATERIALS AND METHODS

Study Design and Data Collection

The paper is based on primary consumer research comprising both questionnaire survey and sensory analysis. The research was conducted in June 2020 by face-to-face survey. Each respondent was asked to fill in a short questionnaire which was complemented with preference testing of selected edible food packaging based on their sensory attributes. The research sample consisted of 22 respondents from Slovakia aged 19–30 years. Respondents represent Generation Z as the most impactful group of consumer trendsetters (Dorsey and Villa, 2020). From a demographic point of view, in the survey participated 59% females and 54% respondents from urban areas. All respondents obtained higher education. The questionnaire survey examined opinions and attitudes toward edible food packaging. Sensory testing analyzed the overall acceptability of selected food packaging by evaluating their taste and taste intensity using a 7-points hedonic scale (1-very bad, 7-very good). In total, respondents tested 23 different flavors of edible food packaging (Table 1). The composition of edible packaging is not indicated due to the filing of a patent application. Essential oils from Hanus s.r.o. were incorporated into the edible films (Nitra, Slovakia, no. 1, 2, 5, 8, 9, 14–23), which are approved

TABLE 1 | Different flavors of edible food packaging.

Sample no.	Flavor of edible food packaging
1	<i>Ocimum basilicum</i> L.
2	<i>Citrus limon</i> L. Osbeck
3	<i>Zingiber officinale</i>
4	<i>Stachys recta</i> L.
5	<i>Citrus paradisi</i> Macfad.
6	<i>Bergeria crassifolia</i> L.
7	<i>Cymbopogon citratus</i>
8	<i>Melissa officinalis</i> L.
9	<i>Salvia officinalis</i> L.
10	<i>Syringa vulgaris</i> L.
11	<i>Tagetes erecta</i> L.
12	<i>Mespilus germanica</i> L.
13	<i>Rumex acetosa</i> L.
14	<i>Juniperus communis</i> L.
15	<i>Malus domestica</i> Borkh.
16	<i>Cymbopogon nardus</i> L. Rendle
17	<i>Foeniculum vulgare</i> var. <i>dulce</i>
18	<i>Citrus aurantiifolia</i>
19	<i>Lavandula angustifolia</i> × <i>latifolia</i>
20	<i>Litsea cubeba</i> Pers.
21	<i>Leptospermum petersonii</i> Bailey
22	<i>Mentha</i> × <i>pipperita</i>
23	<i>Hyssopus officinalis</i>

for internal use and medicinal plants material (no. 3, 4, 6, 10–13, 15) has been professionally identified according to the correct botanical nomenclature, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture.

The study was conducted according to the guidelines laid down by the Declaration of Helsinki and all procedures involving human subjects were approved by the Specialized St. Svorad Hospital Nitra-Zobor Ethics Committee (Protocol number: 1/120620/2020). The research was conducted in June 2020.

Data Analysis

Besides descriptive statistics, we applied non-parametric tests such as the Friedman test and Mann–Whitney U test in order to identify statistically significant differences. Statistical tests were performed using statistical software XLSTAT, version 2021.1.

We formulated the following statistical hypotheses:

- H1: There exists statistically significant differences in the evaluation of different variants of edible packaging.
- H2: There exists statistically significant differences in the evaluation of different packaging attributes.
- H3: There exists statistically significant differences in the evaluation of packaging attributes between men and women.
- H4: There exists statistically significant differences in the evaluation of packaging attributes between urban and rural areas.

RESULTS

The questionnaire survey showed that young generation (54% women and 41% men) are familiar with edible food packaging (68%—heard about it, 27%—know it). Young respondents in this case study were asked which feeling evokes the idea to taste edible food packaging and the most frequent answer were the curiosity (90%). Sensory testing revealed differences in evaluation of taste, the intensity of taste, and overall acceptability between examined samples. Statistically significant differences were confirmed (H1) by applying the Friedman test ($p \leq 0.0001$). A similar level of awareness we find in the results of the consumer survey organized by Pashova et al. (2018) in Bulgaria. This survey demonstrated that the majority of the young respondents, about 60 % were not familiar with the nature of the edible coatings. After further clarifications from the authors of the survey, the young respondents stated that edible coatings should influence the following most important food properties: quality and shelf life—64%; better appearance of the foodstuff—nearly 57%.

The results of sensory evaluation by young people in this case study are illustrated in **Figure 1**. It can be stated that the best rating of taste was obtained by sample no. 22 (*Mentha × Piperita*) followed by sample no. 23 (*Hyssopus officinalis*) and sample no. 17 (*Foeniculum vulgare* var. *dulce*). Sample no. 3 (*Zingiber officinale*) was evaluated as the worst. Regarding the intensity of taste, the most intense sample was no. 19 (*Lavandula angustifolia × latifolia*) followed by sample no. 20 (*Litsea cubeba* Pers.), no. 17 (*Foeniculum vulgare* var. *dulce*). The least intensive taste was rated sample no. 11 (*Tagetes erecta* L.) followed by no. 6 (*Bergenia crassifolia* L.) and no. 10 (*Syringa vulgaris* L.). Based on the taste and its intensity, the respondents evaluated the overall acceptability as well. The best rating was obtained as follows: sample no. 22 (*Mentha × piperita*) > sample no. 17 (*Foeniculum vulgare* var. *dulce*) > sample no. 23 (*Hyssopus officinalis*). The least accepted samples were sample no. 15 (*Malus domestica* Borkh.), sample no. 13 (*Rumex acetosa* L.), sample no. 6 (*Bergenia crassifolia* L.), and sample no. 21 (*Leptospermum petersonii* Balley). Respondents indicated different feelings after sensory testing (11-positive feelings, 11-neutral feelings). Moreover, all of the young respondents stated that in the future they would purchase products with edible food packaging.

Sensory testing was complemented by questions regarding food packaging. In this case study of the young generation we evaluated the importance of different attributes of food packaging such as package shape, graphic design, packaging transparency, production technology, attractive appearance, packaging material, ecological aspect, protective function, and recyclable material. Friedman test revealed statistically significant differences in evaluation between attributes ($p < 0.0001$), therefore H2 was confirmed. The most important attributes by young people were as follows: recycling material > protective function > ecological aspect. The least important attributes were the shape of packaging, graphic design, and transparent packaging (**Figure 2**). Moreover, all respondents in this case study stated that they separate waste (18—regularly and 4—sometimes).

Furthermore, we examined whether gender plays an important role in evaluation of packaging attributes. Results

of the Mann-Whitney test did not confirm this hypothesis (H3). However, the above-mentioned test confirmed statistically significant differences ($p < 0.05$) between rural and urban areas in the following attributes: transparent packaging, production technology, attractive appearance, and protective function (H4). Young respondents living in rural areas rated these factors as more important.

DISCUSSION

In general, there exists very few studies on consumer perception of edible food packaging which are used as novel packaging techniques in the food industry. Therefore, the objective of this study was to investigate the overall acceptability of edible packaging among young consumers in Slovakia. Results showed that all respondents would purchase food products with edible packaging rather than plastic packaged product. The main motive for purchasing is curiosity. Sensory testing identified as the most accepted types based on taste were sample no. 22 (*Mentha × piperita*), no. 23 (*Hyssopus officinalis*) and no. 17 (*Foeniculum vulgare* var. *dulce*). The least accepted were sample no. 3 (*Zingiber officinale*) and sample no. 13 (*Rumex acetosa* L.). Samples no. 19 (*Lavandula angustifolia × latifolia*) had the most intensive taste that can affect adversely consumer acceptance when using for market purposes. This is not desirable since edible and coatings are intended to be consumed with their respective products (Belloso et al., 2009).

In a study by Wan et al. (2007), the sensory quality of coated food products was considered as one of the most important factors toward the purchase intent of the consumer. In the focus group study performed by these researchers to address consumer attitudes, opinions, and concerns toward edible films and coatings, the majority of the panel stated that coating should be transparent and should not possess taste or odor affecting the sensory quality of the product where it is applied except new food product development ideas for applying new coatings as flavor carriers.

Similar sensory research regarding consumer acceptability was conducted on the edible and active coating applied on beef. Participants evaluated taste and the overall acceptability using scaling questions (Vital et al., 2016, 2018). However, according to Aldred Cheek and Wansink (2016), who tested consumer perceptions of edible packaging among university students, the overall acceptability of edible packaging may differ depending on whether the edible packaging is presented as a separate layer or as an integral part of the product. The same opinion was supported by Wan et al. (2007) who stated that in the case of coatings and films which are edible, consumers may perceive differently the coating used as an integral part of the product and the coating used as an additional substance for improving certain product attribute (e.g., texture, shelf life, taste, flavor, scent). Moreover, the additional information about edible packaging may influence consumer acceptance (Aldred Cheek and Wansink, 2016).

Essential oils or their active components generally have strong flavor notes, which might result in the negative impact on the food product when they are used in the production of active edible films and coatings. The effects of 0.5 and 0.75% carvacrol incorporation into an apple- and tomato-based edible

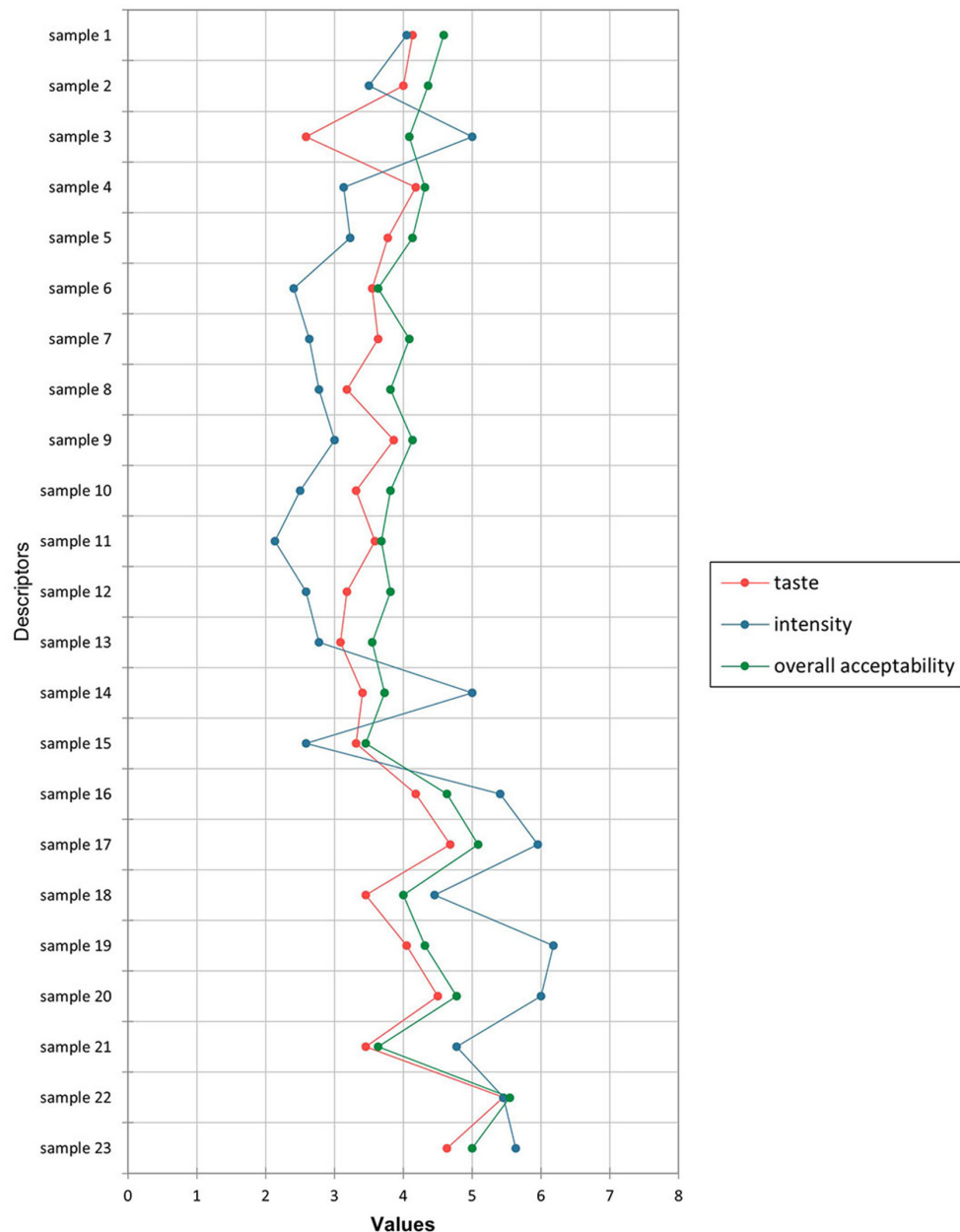


FIGURE 1 | Evaluation of taste, intensity, and overall acceptability of edible food packaging.

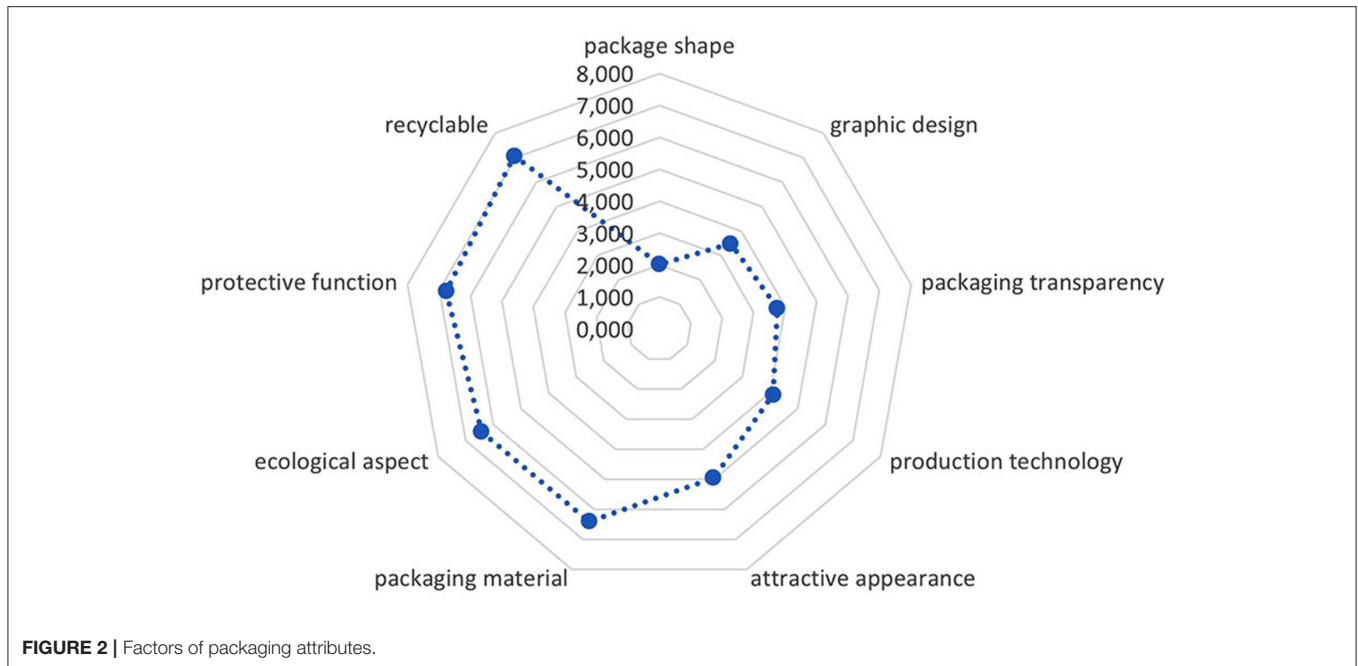
film formulations and 0.5 and 0.75% cinnamaldehyde to apple-based edible film formulations on sensory characteristics of baked chicken pieces wrapped with these films were evaluated by Du et al. (2012).

Limitations

Our research has the ambition to show there is potential for edible packaging use in the segment of young generation in age category 19–30 years. A relatively small sample of respondents has been caused by difficulties to manage sensory testing of a large

number of samples to select the most favorite ones for further processing and studies. This research represents a pilot study conducted only on a small sample ($n = 22$) and specific target group (young consumers) therefore, future research with a higher number of respondents of all age categories should be addressed.

Future research could also study consumer's perception of edible packaging not only as separate layers but as an integral part of a certain product. Our research does not consider the factor of price level perception in terms of buying a product in conventional packaging vs. edible packaging.



Price can be considered as a very important factor affecting a decision to buy a food product with edible packaging. Survey results published by Pashova et al. (2018) show that around 34% of the respondents would buy foods with edible coatings if their prices do not differ substantially from those of the foods they now buy without coatings, and only 13% would buy foods with edible coatings, regardless of their price. Deeper primary research, especially sensory analysis interconnected with biometric research using eye-tracker or face reader to read consumer emotions, facial expressions, and eye movement may show also other differences in perception of edible packaging. Similarly, as Global Opportunity Analysis and Industry Forecast, 2017–2023 for Edible Packaging Market by Material and End Users, we can segment consumers on edible packaging market based on material type, end-user, and region. Based on end user, the edible packaging market is bifurcated into food, beverages, and pharmaceuticals (Allied Market Research, 2017).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Specialized St. Svorad Hospital Nitra-Zobor Ethics Committee (Protocol Number: 1/120620/2020). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

EH, PŠ, MK, TS, and DG contributed to conception and design of the study. PŠ organized the database. KM performed the statistical analysis and wrote the first draft of the results in the manuscript. EH, KM, and PŠ wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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