

## THE CONSUMERS' ACCEPTANCE OF PURPLE-FLESHED POTATO ON THE MARKET IN ROMANIA

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### Abstract

Potato has been consumed for more than four centuries in Europe, and during the last century, it was also the subject of modern biotechnology breeding to obtain different varieties with specific uses. Therefore, new potato varieties have been constantly introduced into the marketplace. Up to the beginning of this century, purple-fleshed potatoes (PFPs) were not very common in Europe, nor in Romania. But, due to their significant nutritional importance, an increase in these varieties' acceptance on the marketplace was observed. While the purple-fleshed potato may offer unique nutritional advantages, challenges may arise in terms of consumer education and acceptance. The scope of this article was to apply a scientific-based questionnaire and to be disseminated with the support of students among the consumers in Sibiu County. A total of 278 answers have been received. Based on the analysis of this survey, it can be concluded that generally, the public is open to accepting different types of potato varieties. However, the need for scientific explanations was considered essential to getting informed answers from all respondents. The most interested in the PFPs seems to be the young generation, most originating from urban or rural areas. Thus, PFPs may have the chance to enter the marketplace in Romania quickly.

**Key words:** novel food, population acceptance and consumption, purple-fleshed potatoes (PFPs)

### INTRODUCTION

Currently, due to its increased adaptability to different pedoclimatic conditions, *Solanum tuberosum* L. is cultivated in more than 120 countries around the world, with potatoes being consumed daily by more than a billion people [9]. Moreover, this species is listed as the fourth most cultivated crop plant in the world [5], after maize (*Zea mays* L.), rice (*Oryza sativa* L.), and wheat (*Triticum aestivum* L.). As it is long-established, potato is a species originating in the highlands of the Equatorial Andes in South America, respectively, in Peru, where two distinct centers of origin have been identified in the regions of Huancayo and Cuzco [4]. Once the idea of the center of origin of culture species proposed in 1917 by Vavilov was accepted, after 1920 a series of scientific expeditions to South America began, which ended with an impressive collection of germplasm

comprising at least 200 species of wild and eight cultivated tuber-producing species belonging to the genus *Solanum*. During this period, potatoes became the subject of scientific research at high standards around the world, especially due to their nutritional potential, as the potato crop became one of the seven pillar crops in the world [2, 24]. Potatoes with purple or red flesh have high concentrations of anthocyanins, but also an antioxidant action four or five times higher compared to potato tubers with yellow or white flesh [11]. Among the most important benefits can be listed: protection of the immune system due to the increased intake of antioxidants present on the flesh tubers; helping to regulate blood sugar; lowering blood pressure; helping to lose weight due to the low intake of fats; and most importantly, they prevent the appearance of tumors or cancer due to the large amount of antioxidants that the purple-fleshed potato (PFP) tubers

have [6, 7, 3]. In terms of nutritional composition, the equivalent of 100 g of raw potato tuber consists of 77.46 g of water, 17.47 g of carbohydrates (mainly starch), 2.20 g of fiber, 2.02 g of protein, and only 0.09 g of fat, all of which add up to 77 kcal [16].

Promoting new potato varieties on the market is crucial for biotech companies to attract the attention of farmers, producers, and consumers. Promoting these varieties at agricultural events provides a direct way to interact with farmers, explaining their advantages and benefits [13]. The acceptance on the market of new potato varieties became a relevant subject for their future trade. The use of both online and offline promotion channels increases awareness and information related to new varieties and their positive influence on new potential consumers [12]. Field trials and practical demonstrations are essential, allowing farmers to witness the performance of new varieties under real growing conditions [1]. This creates confidence and encourages farmers to continue growing new varieties and placing them on the market [25]. By combining these communication strategies starting with 1955, the impact of promotion is maximized, facilitating the successful entry of new potato varieties into the market, followed by consumer acceptance and consumption, and the functioning of the potato market at a new level [19]. To ensure food and nutritional security and, at the same time, to rationally exploit agricultural land, farmers have begun to introduce and cultivate different plant species from exotic areas that can adapt to new climatic conditions [20]. For example, in the last decade, the cultivation of PFP has been adopted by some Romanian farmers. PFPs are not sufficiently known by European consumers, even if they are varieties already adapted to cultivation. For this reason, in Romania, it is very important to promote the market entry of PFP varieties.

The main purpose of this study is to identify the degree of acceptance of PFP among Romanian consumers. The secondary aim of this study is to make potato consumers aware of PFPs marketing, their nutritional and food value, and the potential for inclusion in the

menu by adding this information to a questionnaire with extensive scientific explications.

## MATERIALS AND METHODS

*A. Applied questionnaire for PFP knowledge and consumption.* A Google Form was developed comprising sets of questions related to PFPs knowledge and consumption. These questions were structured in two parts. The first part of the questionnaire had a total of 20 questions, using both closed-ended and open-ended 5-point Likert scale questions. This part aimed to obtain information on the frequency with which the respondents consume potatoes and how they consume them, followed by checking their knowledge of the purple potato and the respondents' openness to consumption.

The second part of the questionnaire consisted of five questions that describe the respondent's typology, such as age, gender, place of origin, last completed studies, and profession. The estimated time for completing the questionnaire was 4-5 min. It was completed online during the year 2020. Each question was accompanied by scientific information related to PFPs and the questioned subject.

*B. Target group.* The questionnaire was released with the support of students of the Faculty of Agricultural Science, Food Industry, and Environmental Protection, Lucian Blaga University of Sibiu. Thus, the primary target group is students studying subjects related to agriculture. The second target group was chosen randomly, regardless of social class, education level, age, or gender. The application of the questionnaire was carried out through media coverage on social networks (a Facebook group specifically in the field of agriculture in Sibiu County), but also through its distribution by students in agri-food local markets from Sibiu and Mediaș city as well as in the rural area of Sibiu County. Upon accessing the link, survey participants were informed of its purpose.

*C. Data analysis and interpretation.* The obtained data were cumulatively interpreted with the help of graphs processed in the Excel

program, a component of Microsoft Office. The proposed sample consisted of 250 respondents. All the answers obtained after submitting the questionnaire were confidential and anonymous, later being interpreted with the statistical program SPSS, version 13.

The Chi-Square test was used for the comparative analysis [18] of the questionnaire items according to the age groups and the urban or rural origin. Only answers that reached the level of statistical significance of  $p=0.05$  were taken into consideration [22].

## RESULTS AND DISCUSSIONS

For more than five centuries, potato cultivation started slowly and continued in a faster way, becoming widespread worldwide due to its adaptability to different climate zones and soil types, but it is noted that it is mainly cultivated in Europe. By analysing the FAOSTAT 2021 database, in 2021 in Europe, Ukraine had an area cultivated of 1,283,200 ha, followed by Russia with 1,142,111 ha and Germany with 258,300 ha. The area cultivated with potatoes in Romania in 2021 was 84,530 ha; our country ranks the 10<sup>th</sup> in Europe.

Potato cultivation at the level of the European Union brought great value to the agricultural sector, so that in 2019, it produced 56.62 million tons of potatoes, worth over 13 billion euros.

However, no data is available about the cultivation or consumption of PFPs. Most popular potato varieties are white-fleshed, but

recently PFPs have entered the marketplace. These potato varieties slowly became more and more popular and were cultivated in many countries, including Romania. For this reason, we conducted a survey and applied a questionnaire among some respondents from Sibiu County to understand the level of knowledge and acceptance related to PFPs consumption. Before resorting to designing the questionnaire, a bibliographic search was made in the Web of Science Core Collection database (WOS) [26] using the keywords `potato acceptance marketing`. This scientific research was made to identify the degree of knowledge of PFPs among the population. In this way, 62 scientific papers related to the searched keywords were identified. All scientific papers, consisting of articles, reviews, or short communications collected from electronic libraries, were published in the last 30 years. Thus, 8 were published between 1993 and 2002, 13 between 2003 and 2012, and 42 between 2013 and 2023. The number of publications is constantly increasing, which means that this topic is relevant for researchers. In the second stage, all articles were analyzed based on their keywords, and the most used keyword was `acceptance` (Fig. 1). However, of the total number of identified papers, only one addresses PFPs. We mention that there are also relevant scientific publications not included as they were not introduced into the WOS database, such as that of 1955 [19].

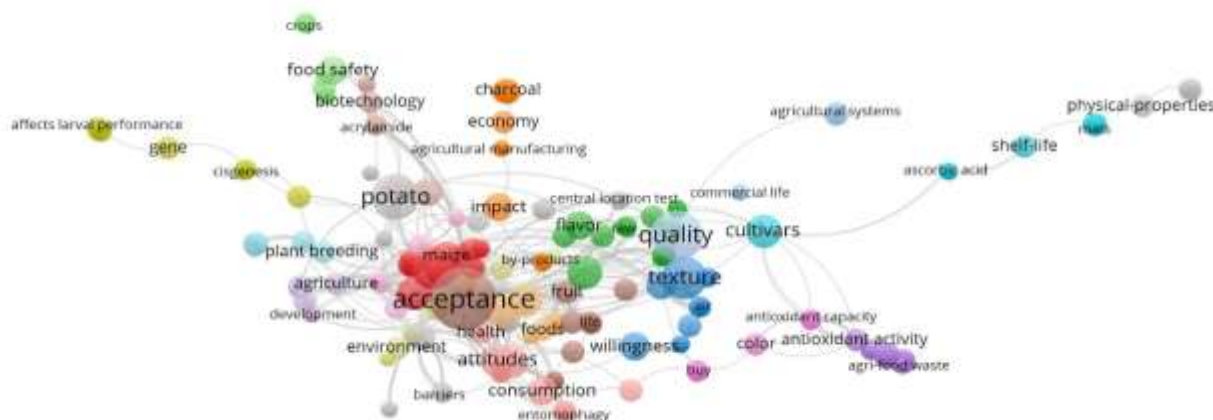


Fig. 1. Graphic representation of cooccurrence of all keywords collected from 62 scientific papers with potato acceptance marketing as a general subject of study. Source: processed data on VOS-viewer, version 1.6.15 [14].

A set of 20 questions were electronically disseminated as a Google Forms questionnaire. Following the dissemination of the questionnaire, 279 responses were collected. The data obtained were presented in the form of frequencies and percentages by applying the Chi-Square test. Related to *potato consumption*, the results are presented in Fig. 2. It can be considered that the younger respondent group (i.e., the 20–25 age group of consumers) is consuming potatoes much more often compared to the elder group (61.63%), compared with ( $p = 0.000$ ) the other groups of age who answered that they would often consume this food (43.75–52.94%).

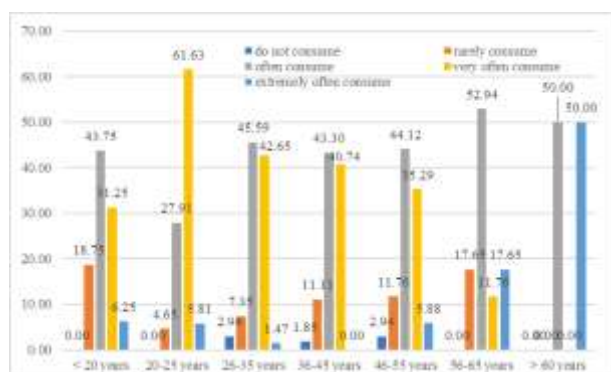


Fig. 2. Frequency of potato consumption by age groups in Sibiu County, Romania ( $p=0.000$ )  
 Source: original by processing obtained data.

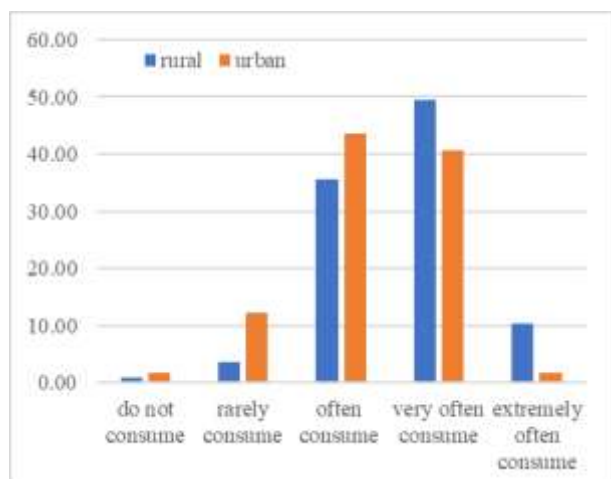


Fig. 3. The frequency of potato consumption according to the rural and urban areas of origin in Sibiu County Romania ( $p=0.002$ )  
 Source: original by processing obtained data.

Depending on the *respondent's origin* (i.e., rural and urban areas) in Fig. 3, the rural respondents (i.e., 49.53%) consume potatoes much more often compared to those from

urban areas (i.e., 43.60%). However, the difference between these two groups is not too high. Considering the *type of potato cooking*, respondents aged up to 35 years preferred fried potatoes (41.18–51.16%), compared to the group over 45 years, who frequently consume mashed potatoes (38.24–41.18%). In this case, no statistical differences were observed for rural and urban area origin groups (i.e., 38.71%).

The respondents' responses to questions regarding *their knowledge about the existence of PFPs* are presented in Fig. 4.

It is observed that the groups of respondents aged between 36 - 45 years, 46 - 55 years, respectively, 56 - 65 years, answered that they are familiar with these varieties (72.22–88.24%), compared to ( $p=0.058$ ) the elder age groups (50.00–68.75%).

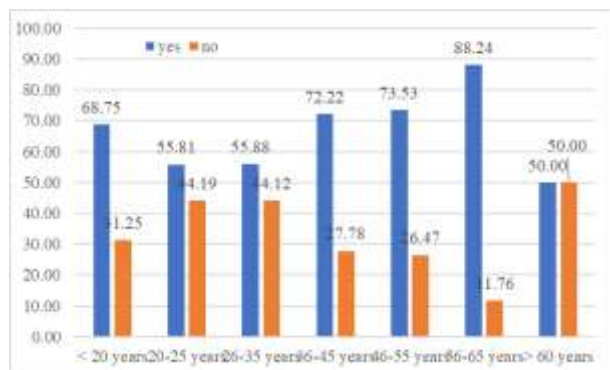


Fig. 4. Knowledge regarding the existence of PFP according to age in Sibiu County, Romania ( $p=0.058$ )  
 Source: original by processing obtained data.

As in the previous case, from Fig. 5, it appears that the same age groups stated that they have seen potato varieties that have purple flesh in stores (44.44–76.47%), compared to ( $p=0.003$ ) the remaining age groups (25.00–50, 00%).

It seems that of the people surveyed under the age of 20, only a percentage, 25.00%, had the opportunity to identify such varieties on supermarket shelves or in the market (Fig. 6). Based on these data it can be considered that the high difference between the people knowing about PFP and its marketing might be due to the misunderstanding of the first question and confusing PFP with red skin potatoes.

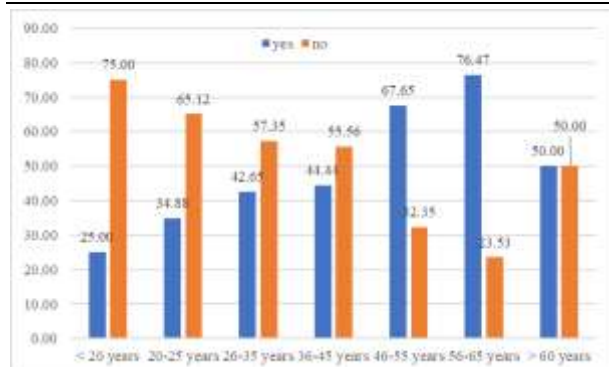


Fig. 5. Knowledge of PFP marketing according to age in Sibiu County, Romania (p=0.003)

Source: original by processing obtained data.

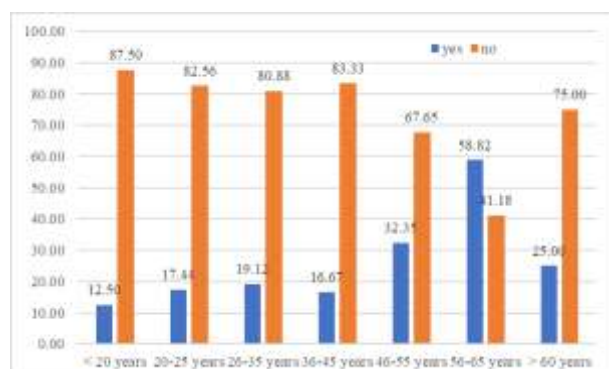


Fig. 6. The purchase of PFP from stores according to age in Sibiu County, Romania (p=0.005)

Source: original by processing obtained data.

In this regard, in vernacular Romanian terms red potatoes are referring to red skin potatoes and not to flesh potatoes.

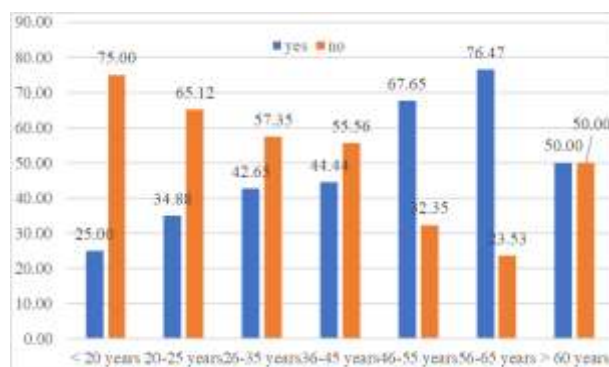


Fig. 7. Sales perception of PFP in Romania according to age in Sibiu County, Romania (p=0.003)

Source: original by processing obtained data.

By analyzing the data presented in Fig. 7, it can be seen that 58.82% of respondents in the 56-65 age group have also bought such potatoes, compared to (p=0.005) the other age groups (12.50–32.50%). And those from the age groups 46-55 years (50.00%), respectively 56-65 years (47.06%) knew that in Romania

PFP are cultivated and marketed by small farmers, compared to (p=0.003) the other age groups (17.44%–25.00%).

Considering the origin of respondents, no statistically significant differences were observed in the existence, trade, and consumption of PFPs.

Another subject was the *knowledge related to anthocyanin richness of PFPs*. Thus, according to the data presented in Fig. 8, many respondents, both rural (40.19%), and urban (53.49%), are supporting the idea that it might be important for PFPs varieties to be cultivated on a larger scale in our country (p=0.022). According to the distribution of respondents by age, no statistically significant differences were obtained.

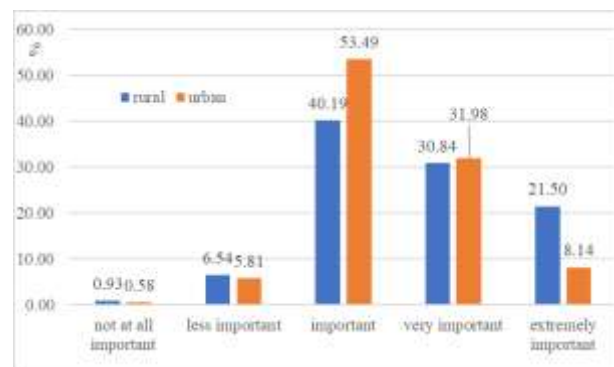


Fig. 8. The importance of PFP cultivation depending on the respondent's origin in Sibiu County, Romania (p=0.022)

Source: original by processing obtained data.

Regarding the *use of antioxidant substances* (e.g., anthocyanins) extracted from PFP (Figs. 9 and 10), respondents under 20 years old (43.75%) and those aged between 20-25 years (36.05%) showed themselves to be very interested, followed by the age groups 26-35 years (61.76%), respectively, 36-45 years (64.81%) who declared themselves interested in this subject, compared to (p=0.012) the other age groups. Regarding the area of origin 41.12% of the respondents who come from the rural area consider themselves interested, and 24.30% extremely interested, compared to (p=0.011) those who come from the urban area, where 52.33% are interested and only 9.30% extremely interested in this topic. It is relevant to mention that scientific data have been provided to all respondents inside the questionnaire during the survey.

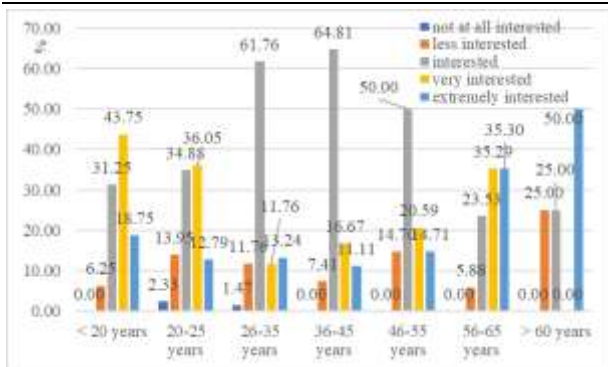


Fig. 9. Interest in anthocyanins extracted from PFP according to age of respondents from Sibiu County, Romania ( $p=0.012$ )  
 Source: original by processing obtained data.

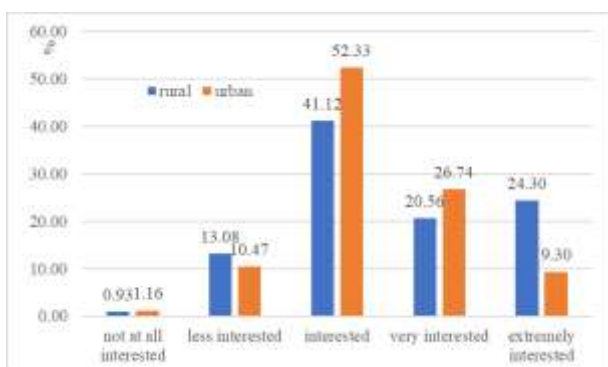


Fig. 10. Interest in anthocyanins extracted from PFP according to origin of respondents in Sibiu County, Romania ( $p=0.011$ )  
 Source: original by processing obtained data.

Another question was related to the potential consumption status of PFPs fresh and cooked. Thus, the data analysis revealed that the respondents are open about the consumption of plants or tubers in a fresh state, obtained *in vitro* (Fig. 11 and Fig. 12), so that from the age category under 20 years (50.00%) they declare very willing to try, followed by the age groups 20-25 years, 26-35 years, respectively 36-45 years (41.86%–55.56%). They stated that they are willing to consume, in this form, potato varieties rich in antioxidant compounds, compared to ( $p=0.002$ ) the other age classes.

If we look at the area of origin of the people surveyed, 47.66% respondents who come from rural areas declare themselves willing to consume seedlings and/or microtubers, followed by 19.63% who are very willing and extremely willing, compared to 7.56% urban respondents ( $p=0.015$ ) who are extremely open to eating such foods. The elder group

seems not to be so interested due to their difficulty understanding how to apply cruse potatoes in cooking recipes (Fig. 12).

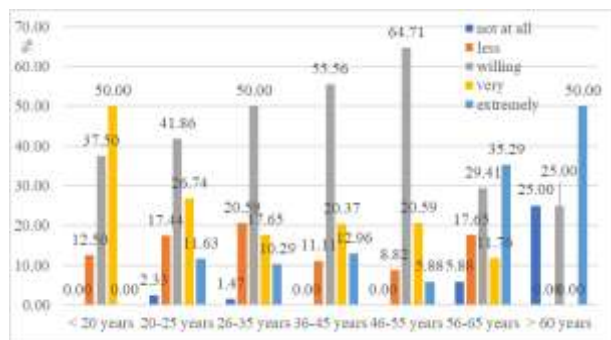


Fig. 11. Openness to the consumption of plantlets and microtubers according to age from Sibiu County, Romania ( $p=0.015$ )  
 Source: original by processing obtained data.

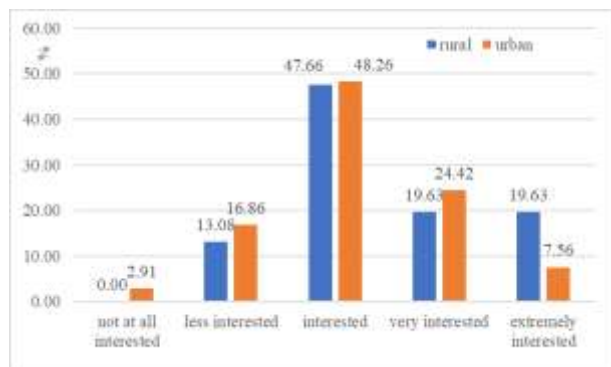


Fig. 12. Openness to the consumption of plantlets and microtubers according to the origin of respondents ( $p=0.015$ )  
 Source: original by processing obtained data.

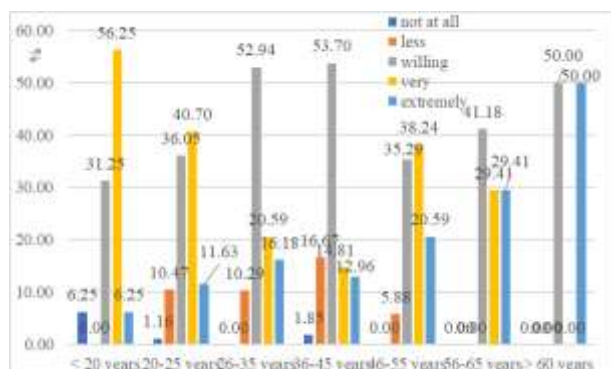


Fig. 13. Considering PFP a 'novel food' according to age of respondents from Sibiu County, Romania ( $p=0.020$ )  
 Source: original by processing obtained data.

Taking into account the market price of PFP varieties and the potential labeling as novel food (approximately 3-4 times higher than white-fleshed varieties) and also the fact that a limited number of the population knows these

varieties, respondents under 20 years of age and those aged between 20-25 years (40.70–56.25%) consider it very important that this food is considered `novel food` on the territory of our country, while the categories aged between 26 and 65 years, with the exception of respondents aged between 46-55 (36.05%–53.70%) were of the opinion that it is important for the food to be classified as `novel food`, compared to ( $p=0.020$ ) the other age groups (Fig. 13.).

In rural areas, 32.71% of respondents believe that it is very important that these potato varieties are considered `novel food` and 22.43% answered that it is extremely important, compared to ( $p=0.006$ ) 51.74 % urban respondents who think this label is important for purple-fleshed potato (Fig. 14).

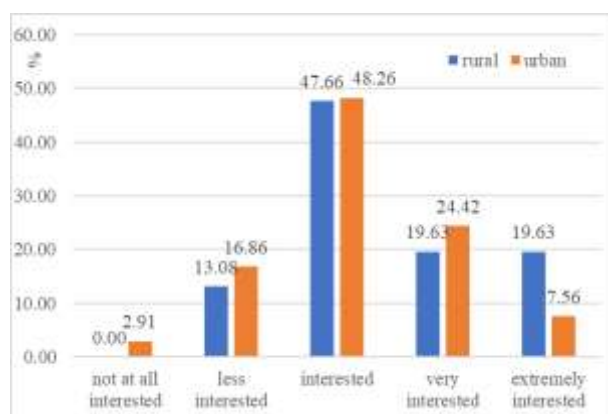


Fig. 14. Considering PFP a `novel food` according to origin of respondents in Sibiu County, Romania (0.006)  
Source: original by processing obtained data.

From the total number of respondents (278), most declare that they graduated from a bachelor's degree program (37.30%), followed by high school graduates (29.70%), master's degree (25.10%), secondary high school (4.70%) and in the end, PhD study (3.20%). From there, we can see that the level of education of respondents can influence their understanding of the term `novel food`. People with a higher level of education and life experience may have a better grasp of concepts related to food, enabling them to comprehend the complexities of novel foods and their implications. In this way, education and experience can play a crucial role in shaping a person's ability to comprehend and

critically evaluate information about innovative or unfamiliar food products.

A whole series of studies from abroad revealed the need to evaluate consumer preferences for certain characteristics of potatoes as food [15]. The main objective of these studies was to generally support a certain policy in the market regarding the increase or decrease of the proportion of some varieties of potato compared to others. Such studies have been carried out in America, Europe, Africa, and Asia [1, 8, 23, 10, 21]. In addition to the promotion of certain varieties, there are other studies that aim to follow the effect of purple potato consumption in Japan [17]. The first associations of the potato with the term `novel food` were made in 1993, for genetically modified potatoes when researchers studied consumers' perception of the degree to which `novel food` foods are dangerous and, at the same time, their openness to their consumption [23].

## CONCLUSIONS

Regarding the degree of knowledge of *Solanum tuberosum* L., PFP varieties, among the Sibiu County population, a percentage of 36.20% of all the surveyed respondents stated that they did not know that there are potato varieties that have the whole pulp of the tuber completely colored in purple, and 69.90% of all respondents have never consumed such potato varieties. Also, when the benefits of consuming these varieties were listed, only 1.80% of respondents stated that they were not willing to try consuming, purple-fleshed potato varieties in any form. Old age generation is more resistant to include fresh potatoes in their diet also due to medical conditions. A higher level of education generally correlates with a better understanding of all newly introduced terms. These results highlight the respondents' openness to accepting new varieties of potato in their diet.

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