Research Article

Preservice Science Teachers' Perceptions of Artificial Meat in the Context of Socio-Scientific Issue*

Fatih AYDIN [1]

Abstract

The aim of this study is to analyse the issue of ''Artificial Meat'', which is scientifically and socially controversial, in the context of a Socio-Scientific issue from the perspective of preservice science teachers. In this study in which qualitative research method is used, the issue of ''Artificial Meat'' is dealt with as case study. Preservice science teachers (N=37) took part as participants. The participants were included on a volunteer basis and the criterion sampling method from the purposive sampling types. Data were obtained with two different ways. Firstly, scanning regarding Artificial Meat and making an infographic were demanded from the participants. Secondly, it was demanded from the participants to evaluate the issue of ''Artificial Meat'' in the context of Socio-Scientific Issue. The content analysis was practiced over all the obtained data. It is seen that the results are similar. The participants have both positive and negative point of view regarding artificial meat. It is seen that the factors reflecting negative point of views are mostly within the frame of social factors while the factors reflecting positive point of views are environmental impacts besides economy and cost. Considering that in the context of Socio- scientific issues, we can see two results. First one is that the issue of "Artificial Meat" can be evaluated as a Socio- Scientific issue. The second one is that the factors revealing in the findings can be considered as the practicable factors in the education of the artificial meat in the context of socio-scientific issue.

Keywords: Preservice science teacher, socio-scientific issue, artificial meat, infographic

1. INTRODUCTION

Both scientific and technological developments and the increasing relationship between the technology and society lead to the studies in this context naturally. It is known that one of the studies in this context which is undoubtedly remarkable and considerably gaining importance especially in the science education is Socio- Scientific Issues (SSI). The topics such as genetically modified organisms (GMO), nuclear power plants, cloning, organ donation, vaccination, hydroelectric power plants can be exemplified for these issues (Aydın & Kılıc-Mocan, 2019). SSIs are issues which don't have only a solution, are needed to develop different point of views from person to person or a society to another society and make a decision, controversial and complicated, contain ethic, moral, legal, social and political aspects (Ratcliffe & Grace, 2003; Sadler & Zeidler, 2005). The decisions taken related to socio-scientific issues can influence the present and future situations of the societies in terms of politics, economy and science and technology (Degirmenci & Dogru, 2017). A science literate person is needed to be a person who can make a decision effectively for the solution of a socio-scientific problem with which he/she can confront in the daily life (Sadler, 2004). In the same way, Eastwood, Schlegel and Kristin (2011) and Sadler (2011) also expressed that the instruction schedules containing socio-scientific issues influence positively the students' moral, logical and critical thinking and making decision when they confront with socio-scientific problems in their daily lives. When these characteristics of SSI stated above are evaluated, the issue of artificial meat which has a similar content draws attention. Artificial meat can be conceptually expressed in the literature as "artificial

Received Date: 25/04/2021 **Accepted Date:** 17/09/2021 **Publication Language:** English

***To cite this article:** Aydın, F. (2021). Preservice science teacher's perceptions of artificial meat in the context of socio scientific issue. *International e-Journal of Educational Studies (IEJES), 5* (10), 118-132. DOI: 10.31458/iejes.927717

[1] *Prof.Dr., Bolu Abant İzzet Baysal University, Bolu, Turkey fatihaydin14@gmail.com*

Corresponding Author e-mail address: fatihaydin14@gmail.com

meat" (Bonny, Gardner, Pethick, & Hocquette, 2015), "in-vitro meat" (Bhat, Kumar, & Bhat, 2017) and "cultured meat" (Tuomisto & Teixeira de Mattos, 2011).

1.1. Artificial Meat in the Context of Socio-Scientific Issue

It is estimated that the global meat consumption is 311,8 million ton (Food and Agricultural Organization of the United Nations [FAO], 2014) and the meat consumption will double in the next 40 years because of globally increasing population and meat consumption (FAO, 2006). According to FAO (2011), the conventional meat production capacity is maximum or close to maximum. As a result, the meat will become scarce, more expensive and eventually a lux food (Kumar, Berwal, Pandey, Sharma, & Sharma, 2017). Bonny, Gardner, Pethick and Hocquette (2015) point to 4 main issues which the meat industry faces with. These are sustainability both today and in the future, health and security, welfare and market reasonableness. The present meat production methods are related to many problems such as animal welfare issues, the risk of contagious animal diseases, the diseases related to nutrition, resource utilization, and erosion, the loss of habitat and biodiversity and environmental pollution. In consideration of this big negative impact of the conventional meat production on the health and environment, artificial meat makes a great promise as alternative for cut of animal meat on the condition of exceeding consumer resistance. Artificial meat consumption has many health and environmental benefits and it is expected to be reliable meat source humanely, chemically and microbiologically (Bhat, Kumar & Bhat, 2017). When considering more than 95% of the human population eat meat, it would be wise for the promoters of the cultured meat to focus on this population (Hopkins, 2015). The excessive consumption of conventional meat poses one of the biggest threats for the humanity and other creatures. Because of environmental, ethic and social concerns of conventional meat, an easy to transition and a clear alternative is necessary (Moritz, 2017). Besides all of these, Mattick, Landis and Allenby (2015) accept that artificial meat has potential for increasing food security and human welfare, reducing suffering of animals and some environmental impacts related to meat production. According to them, nearly a certainly unexpected result will accompany with these benefits. Supposing that a transition from animal husbandry production in favor of in-vitro meat is understood exactly is to simplify extremely the interdependent nature of technology, society and environment. Bonny et al. (2015) confirm that the conventional meat production can't respond to the increase in the demand of animal protein. They state that new solutions should be found for animal welfare, health and sustainability.

While comparisons between conventional and artificial meat continue in the literature, indeed, the consumer researches compose the most important part of the issue. Accordingly, many consumer researches reveal the manners towards artificial meat in individual and social level with suspicious results. The acceptance of the artificial meat depends on majorly demographic characteristics and individual values (Bonny et al., 2015). It can be many reasons of diversity of opinions related to meat consumption. While some people value the human life as the most valuable thing, the others thinks the environment is also valuable. The relationships with the farmers or animals can affect the perceptions of the people regarding the issue (Vinnari & Tapio, 2009). Siegrist (2008) has found that the benefits, risks and naturality perceived related to food technology affect whether technology is accepted by the public or not. Grunert, Bredahl and Brunso (2004) have found that the cost and internal/external quality factors affect the decision of buying a product. The internal factors are directly related to the product and contain meat color, fat, marbling and sensual quality. The external factors, on the contrary, are more special and contain cost, brand, origin, production methods, health, animal welfare, security and sustainability (Bonny et al., 2015). Wilks and Phillips (2017) analyzed by online survey in 2016 how the participants perceive artificial meat. In the result of the study, they have found that the people are willing to try artificial meat and the males have more positive opinions than the females. Besides that, they detected a range of potential obstacles and categorized them into 9. These are the taste/appeal of the product (79%), ethic concern (24%), price (20%), health concerns (4%),

security concerns (3%), religious reasons (3%), environmental concern (1%) and economic impact (1%). Hocquette et al. (2015) revealed that educated consumers don't expect the artificial meat will be a sustainable solution for the problems related to factory farming. Laestadius (2015) reveals both positive and negative perception of the ethic of artificial meat in the commentary of 814 ABD blog. These values are as follows: (1) animal welfare, (2) the protection of environment and sustainability, (3) developing of justice and equality, (4) the protection of naturality in food system and (5) maximize the scarce resources for social income. While predominant comments are present related to each of these, there isn't consensus on ethic performance of any these five values. So, even if it seems as an important potential for its real benefits to animals, environment and human health, the practical ethics of artificial meat is not clear. Shaw and Mac Con lomaire (2019) states that urban consumers concern more related to environmental and ethic points of meat produced conventionally, and so the possibility of their buying organic meat is high and they are more positive to try alternative products. It is seen that the consumers in the countryside are less willing to try artificial meat. As a result, as it is stated by Bryant and Barnett (2018), the researches made on the acceptance of artificial meat by consumer have found important demographic differences at the rates of acceptance. Increasing familiarity, commercial utility, media scope and the ability of trying artificial meat are the factors which can increase the consumers' acceptance in the future. The longitudinal studies providing us to observe how the manners change in time are of vital importance in future. As Fernandes, de Souza Teixeira, Palma Revillion, and de Souza (2020) stated, an issue which arouses interest of the researchers especially in biological and social science is synthetic meat production by the regenerative tissue engineering practices. As this process is implemented more, the debates containing moral, ethic and religious aspects become bigger.

1.2. The Significance and the Aim of the Study

Socio-scientific issues have gained remarkable importance in Turkey in recent years. This importance clearly shows itself when socio-scientific issues are emphasized in the Science-Technology-Society-Environment learning domain in the 2013 Science Course (3-8 grades) Curriculum (MoNE, 2013). In addition, one of the main aims of the curriculum is to develop scientific thinking habits by using socio-scientific issues (MoNE, 2013, p.2). As it is well known, preservice science teachers will be the implementers of the curriculum, so the curriculums are taken into account in their training. For this reason, the necessity of identifying and developing the perceptions of preservice science teachers in the context of socio-scientific issues is clearly evident. As stated by Genç and Genç (2017), when researches on socio-scientific issues in Turkey are examined, it is understood that university students are mostly preferred in terms of the sample group. Therefore, especially because the issues are included in the Science Course (3-8 grades) Curriculum, preservice science teachers were included in this study.

Another important point of the study is the content of the issue. As it is understood from the literature, the issue of artificial meat is a quite controversial issue both scientifically and socially. As such, it is possible to consider the issue of artificial meat in the context of a socio-scientific issue. At the same time, when we look at the studies on socio-scientific issues, it is seen that there are studies on many different issues. For example, Genç and Genç (2017) examined the articles between the years 2000-2014 published on socio-scientific issues in Turkey. And, Aydın and Kılıç-Mocan (2019) examined the articles and thesis between the years 2008-2018 published on socio-scientific issues in Turkey. In these reviews, studies about SSIs mostly focused on global warming, nuclear energy, GMO, biotechnology, cloning, etc. As such, the issue of artificial meat is utilized, which is considered in this study, both draws attention as an innovative issues and makes a significant contribution to the literature in terms of training preservice science teachers and 3-8 grade students.

The aim of the study is to analyze the issue of artificial meat which is scientifically and socially controversial, in the context of a Socio-Scientific issue from the perspective of preservice science teachers. Thus, it will be seen which controversial points the preservice science teachers consider about the issue of artificial meat.

2. METHOD

In this study, the qualitative research is used and the issue of artificial meat is dealt with as a case. So, the study was designed as a holistic single case design (Yin, 2018). Yin (2018, p. 50) defines the case study as an empirical research which searches a modern fact in the context of real life, especially when the limits between the phenomenon and context is not clearly evident. In addition, Yin (2018, p. 98) states that one of the reasons for a single case study arises when a researcher has the opportunity to observe and analyze a phenomenon that was previously inaccessible to social science research. In this study, the absence of any study on this subject with preservice science teachers and the fact that preservice science teachers do not have any experience in this issue necessitates a holistic research. Cohen, Manion and Morrison (2018) claim that one of the distinctive characteristics of the case studies is to have an integrity which requires to search people systems thoroughly. As can be understood from the literature, the subject of artificial meat includes nutrition, environmental problems, sustainability and many other sub-dimensions. This is valuable in that it can be seen in what context and to what extent these sub-dimensions, which may require in-depth research, are taken into account by preservice science teachers. In this study, perspectives were tried to be determined within the framework of these sub-dimensions mentioned in the literature.

2.1. Participants

In this study, preservice science teachers (N=37) who study at faculty of education at 4th grade in the fall semester of 2019-2020 took part as participants. The participants were included in the study on a volunteer basis and the criterion sampling method from the purposive sampling types (Patton, 2014, p. 424). The participants have a background fulfilling the necessities of the study in the context of the criterion sampling.

Firstly, the participants have knowledge related to SSI and performed practices related to these issues in the undergraduate education and succeeded. Namely, the participants attended special teaching methods I and II courses, which are included in the 3rd year undergraduate education curriculum and carried out in 2 semesters. Practices related to argumentation, debate, thinking with six hats and brainstorming among the methods and techniques taught in this course were carried out through SSI examples (nuclear power plants, GMO, armament, global warming, artificial intelligence and organ donation). As it is known, these methods and techniques require collecting data on the any subject, using these data, and being able to see different points (positive, negative, etc.) of the subject. Thus, the participants gained experience both by seeing different points related to SSI and by looking at it critical due to the nature of the methods and techniques. Therefore, it is known that the participants have experience that will present their perspectives about SSI. It is necessary for the participants to have such an experience in order to present their perspectives on artificial meat, which is the issue of the study, in the context of SSI.

Secondly, an infographic practice has been carried out in this study. Infographics are tools where information and data can be organized and presented in different visual forms such as graphs, tables, maps and pictures (Yıldırım, Yıldırım, Çelik & Aydın, 2014; Turan-Güntepe & Dönmez-Usta, 2017). Therefore, as noted by Meeusah and Tangkijviwat (2013), infographics have an important role in organizing data and thus help people to understand content easily. In the study, it is necessary for the participants to have sufficient equipment to prepare infographics in order to use the information

and data in presenting their perspectives on artificial meat. The equipment of the participants on this issue was carried out in two steps. Firstly, the participants completed the instructional technologies and material design course with a success score of 90-100 points. The fact that they received training on visual design in the content of this course shows their competence of visual designing. Secondly, the participants had 3 week infographic preparation training. In this training, practices were done for examining, designing and preparing infographics in computer environment. The trainings were carried out by the researcher who expert and gave trainings on this practice. In the first week of the training, infographic examples on the internet were examined in the context of visual design elements. Afterwards, sample infographics were designed together with the researcher by using infogram and pictochart, which are infographic preparation programs. In the second week of the training, the participants were asked to prepare an infographic on a topic they chose. In this process, the researcher gave feedbacks and the development of infographics and the skills for the use of related programs were increased. In the third week, all participants presented the infographics they prepared in the classroom environment to each other. Thus, all infographics were discussed by the researcher and participants in the context of both visual design elements and the basic criteria to be considered in order to prepare a good infographic as stated by Davidson (2014). These principles are;

1. *"A good infographic tells a story or presents a position.*
2. *The title of the infographic stands out and fits the contents and message.*
3. *The text can be read easily and contrasts with the background.*
4. *Images are clear, relevant, original or copyright free, and credited.*
5. *Fonts, shapes, and colors are consistent throughout."*

In line with the suggestions presented as a result of the discussions, the infographics were finalized. At the end of all this training, it was seen that the participants were equipped to prepare infographics using the relevant programs.

2.2. Data Collection

Multiple data collection methods are frequently used in the case study researches (Johnson & Christensen, 2008; Yin, 2018). In this study, the data collection was carried out in two different ways. Firstly, it was demanded from the participants to scan related to Artificial Meat and make an infographic within the frame of their obtained data. The reason of collecting data through infographics is to use the combination of images and words in the infographics at the presentation of complicated qualitative and/or quantitative knowledge (Toth, 2013). Although the participants presented quantitative data on artificial meat (for example, the cost value of artificial meat), these data do not serve the aim of the study. Because the aim of this study is not to raise awareness about artificial meat, but to determine within which categories artificial meat is perceived in the socio-scientific context. Therefore, quantitative data were not taken into account.As stated by Heer, Bostock, and Ogievetskey (2010), visualizing data makes data accessible and attractive to a diverse audience. In recent years, visual presentation has been seen as an "emerging field of practice and inquiry" in the field of science education (Gilbert, 2008). Thus, it was ensured that the perspective created by the participants about artificial meat and the way they inquired the issue could be examined from a holistic perspective.

Secondly, it was demanded from the participants a composition in which they evaluate the issue of ''Artificial Meat'' in the context of Socio- Scientific Issue considering the data they obtain from scanning (Yin, 2018). The views of the participants on this issue were collected in written form. The reason of collecting the views in written form is bringing them enough time to present their evaluations precisely. 5 days were given to the participants for this and this time was seen sufficient. A certain question form wasn't used while getting views. This is because the participants have

experience that will present their perspectives about SSI, so it was provided for the participants to make their evaluations freely from their perspectives.

2.3. Data Analysis

Inductive content analysis (Patton, 2014, p. 791) has been carried out over all the collected data. Qualitative inductive analysis refers to generating new concepts, explanations, conclusions and/or theories from specific data in a qualitative study. So, inductive analysis involves discovering patterns, themes, and categories in one's data (Patton, 2014). This coincides with the interpretative (developing conceptual categories inductively to examine initial assumptions) type of case study , which is one of three types identified by Merriam (1988), which is consistent with Yin's (1984) classification (Cohen, Manion and Morrison, 2018). Analyses were carried out together by a researcher and an expert who has studies on the socio-scientific issues in the field of science education. In the process of analysis, it didn't occur any conflicts in the decodings. So, analysis findings belonging to all data in the study have been presented. It has been determined in the content analysis of the infographics from which perspective and at what rate the participants approached to the issue of artificial meat. For this, all images, graphics and explanations have been decoded categorically. For example, as can be seen in Figure 1, if less greenhouse gas and less land need are emphasized with artificial meat production in the infographic, this perspective is coded as environmental effects (in the context of advantages). Similarly, factors such as the increase in the need for meat as a food source and the decrease in stocks are coded as necessity of artificial meat.

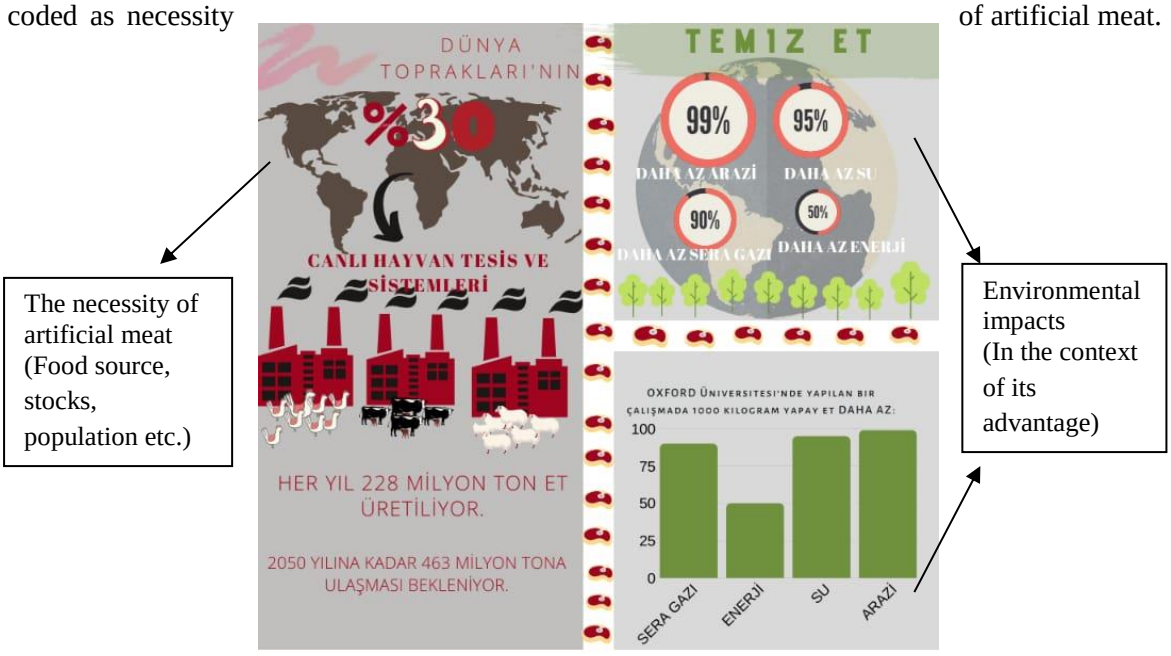

Figure 1. An example analysis coding

In this coding process, as can be seen above, the way in which the participants presented their perspectives (whether with graphics or symbols and pictures) was not considered. As stated under data collection, it is aimed to capture the perspective in their minds by giving them the opportunity to use symbols, graphics, pictures and ect.

In the content analysis of the views collected in written form from the participants, it has been determined by which factors the issue of ''Artificial Meat'' as a Socio- Scientific issue was evaluated. For this, firstly, each participant was decoded with a code number in the way of P1, P2, … Then, the data were decoded and these decodings were collected under certain categories. SSIs are issues which don't have only a solution, are needed to develop different point of views from person to person or a

society to another society and make a decision, controversial and complicated, contain ethic, moral, legal, social and political aspects (Ratcliffe & Grace, 2003). In this analysis process, first of all, it was determined which elements the participants drew attention to in the context of artificial meat. Afterwards, their perspectives on these elements, which they drew attention to, were examined as completely positive, completely negative or dilemma (positive and negative together). Thus, it was determined within the framework of relevant factors whether the participants produced different perspectives both individually and comparatively. Sample codings for this analysis are presented below. For example, P20 have perspectives the issue of artificial meat in a completely positive way and as a food source with the statement "*I think artificial meat is the best and the most harmless of these resources*". And, P15 have perspectives the issue of artificial meat in a completely negative way and as human health with the statement "*I think that it is unhealthy and will get negative opinions because it is synthetic*". Also, P11 have perspectives the issue of artificial meat in a dilemma and as economy with the statement *"If artificial meat is produced in our country, the foreign dependency can be reduced. However, it can make a trouble for the citizen who earns a livelihood by animal husbandry."* So, in both analyses, the place (controversial structure) of the issue of artificial meat in the context of socio-scientific issues has been revealed.

2.4. Validity and Reliability

The construct validity of the study is provided by taking the participants' views related to data diversity and analysis result (Yin, 2018). Accordingly, the data diversity was carried out with the infographics and written compositions as stated in the section of data collection. With regard to the participant's view, a report was presented to the 5 participants randomly after the analyses were done and their approvals were received for the accuracy of the analyses. With regard to the internal validity of the study, as proposed by Merriam (1998), the view of an expert who has studies related to the socio-scientific issues in the science education was taken for both the methods of data collection and the findings. All the processes have been defined clearly and the data have been presented in a supportive way each other in terms of the reliability of the study (Yin, 2018). As stated in the data analysis, since the encodings are carried out together by the coders and there is no conflict, the percentage of agreement between the coders can be specified as 100%. Voluntary participation of the participants in the study is important in terms of reliability. In addition, the participants were informed that the results of the study would be shared with them. This approach has been effective in ensuring participant reliability. Thus, the study gained a quality that could be confirmed by the participants (Patton, 2014). In addition, there was no disagreement with the participants.

3. FINDINGS

When the findings of the participants are examined, it is seen that they do not present exactly the same elements in their infographics and compositions. For example, a participant sometimes presents the relevant point of view only in the infographic or only in the composition. For this reason, it can be evaluated that composition writing together with infographics can be effective in obtaining more in-depth data.

When examining the findings obtained from the infographics of the participants, it is seen that different themes and categories related to artificial meat has revealed. The findings related to these themes and categories are presented at Table 1.

Table 1. The findings obtained from the infographics

Themes	Categories	Participants	f
Advantages of artificial meat	Environmental impacts	P1, P2, P5, P6, P7, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18, P19, P20, P21, P22, P24, P25, P26, P27, P30, P31, P32, P34, P36, P37	29
	Cost	P7, P9, P15, P16, P17, P19, P20, P22, P23, P25, P28, P30, P31, P34, P35, P36, P37	17
	Predictions for the future	P1, P5, P11, P20, P21, P23, P25, P33, P37	9
	The necessity of artificial meat (Food source, stocks, population etc.)	P2, P5, P13, P16, P17, P23, P27, P37	8
	Social impacts	P4, P11, P15, P20, P26, P31, P35	7
	Animal impacts	P4, P11, P15, P17, P35	5
Disadvantages of artificial meat	Hesitations (Taste, content, image, trade, etc.)	P4, P7, P12, P17, P21, P22, P23, P30	8
	Social impacts	P7, P11, P12, P15, P23, P36	6
	Predictions for the future	P4, P18, P22, P29, P35,	5
	Environmental impacts	P15, P28, P32, P35	4
Introducing artificial meat	Production Process	P1, P2, P4, P6, P7, P8, P9, P10, P11, P12, P14, P15, P16, P17, P20, P22, P24, P26, P31, P33, P34, P35, P36	23
	Initials (first product, first company, first year, etc.)	P2, P4, P5, P9, P11, P12, P15, P18, P23, P24, P25, P27, P28, P29, P30, P31, P33, P34, P35, P36, P37	21
	Production – Consumption comparisons (country, region, etc.)	P1, P5, P12, P13, P14, P16, P17, P18, P22, P25, P27, P31, P36	13
	Natural/ Artificial meat comparisons	P6, P8, P9, P13, P16, P33, P34, P37	8
	Survey studies related to the issue	P4, P5, P8, P7, P11, P15, P24	7

It is seen in Table 1 that the perspectives presented by the participants in their infographics are formed under 3 themes: Advantages of artificial meat, disdvantages of artificial meat and introducing artificial meat. The meaning of the categories that emerged under these 3 themes and which elements they represent in the infographics are presented in Table 2.

Table 2. The meaning of the categories that emerged from infografics

Themes	Categories	Meaning
Advantages of artificial meat	Environmental impacts	The fact that artificial meat production is advantageous for the environment due to less greenhouse gas emissions, less energy, water, good pollution and land use.
	Cost	The decrease in the cost of artificial meat production from extremely high values to reasonable values.
	Predictions for the future	With artificial meat production, the need for meat will be met in the future and new job opportunities will be offered.
	The necessity of artificial meat (Food source, stocks, population etc.)	The need for more food sources (as meat), the need to increase stocks, the increase in meat consumption due to the increase in the human population, higher quality and faster production.
	Social impacts	Ensuring equality by delivering artificial meat to all humanity, hygienic, fewer health problems and a healthier nutritional content.
	Animal impacts	Non-destruction of living things through the use of artificial fertilizers, less slaughter for food, and animal rights (suffering).
Disadvantages of artificial meat	Hesitations (Taste, content, image, trade, etc.)	How artificial meat will taste, what will be included in its content, how it will look, how the trade will take place, and the continuity of its consumption.
	Social impacts	It is not reliable for humans, unemployment problem for people dealing with animal husbandry, causing ethical concerns.
	Predictions for the future	Artificial meat will pose a safety problem, mass production can be started and production from different animals can be achieved.
	Environmental impacts	Disruption of ecological balance by artificial meat production.
Introducing artificial meat	Production Process	Presentation of the artificial meat production process by supporting with visuals.
	Initials (first product, first company, first year, etc.)	Providing information on the historical production date, year, company and cost of artificial meat.
	Production – Consumption comparisons (country, region, etc.)	Comparative presentation on the production and consumption of artificial meat within the framework of the preferences of countries, regions, human communities.
	Natural/ Artificial meat comparisons	Production and consumption of natural and artificial meat, cost changes and environmental impacts.
	Survey studies related to the issue	Presenting the results of human research on artificial meat consumption.

When analyzed Table 1, participants underline the advantages related to artificial meat more while underlining its disadvantage less. For example, most of the participants (f:29) mention the environmental impacts of artificial meat in the context of its advantage (such as less greenhouse gas, less area need) while very few of them (f:4) mentions in the context of its disadvantages (destroying ecological balance etc.). In terms of its animal impacts, it is seen that the participants (f:5) touch on the issue only in the context of its advantages. In the context of its animal impacts, the participants emphasize that less death and disease will occur by artificial meat. The participants give information by mentioning the production process of artificial meat (f:23) and its initials (f:21) (first product, first company etc.). These information don't reflect any point of views and are given only with the aim of introducing artificial meat. On the subject of cost (f:17), the participants mention about the artificial meat's being cheaper in time and emphasize its advantages. On the subject of the predictions for future, it is seen that the participants emphasize both its advantages (f:9) (fulfilling the need of meat etc.) and disadvantages (f:5) (safety problems etc.). It is seen that there are participants (f:8) who emphasize the advantages by stating the necessity of artificial meat as well as the participants (f:8) who emphasize the disadvantages by stating the hesitations. On the subject of the social impacts of artificial meat, it is seen again that the participants emphasize the advantages (f:7) and disadvantages (f:6) at similar rate. It is understood that the emphasises in the context of its advantage are on the issues such as equality and health while the emphasises in the context of its disadvantages are on the issues such as unemployment and energy problems. The participants (f:7) emphasize the consumer researches also stated in the literature by giving place to the survey studies in their infographics. Examples of a part from infographics prepared by the participants are presented in Figures 2 and 3.

Figure 2. A part from an infographic

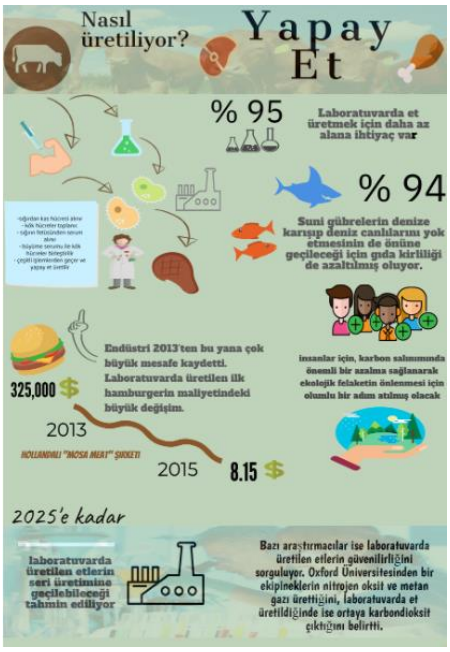

Figure 3. A part from an infographic

When examining the views of the participants regarding their evaluation of the issue of artificial meat in the context of Socio- Scientific Issue, it is revealed that the point of views at different categories are present. These are ''human health'', ''environment'', the need of food and its quality'', ''economy'', ''culture'' and ''the protection of animals''. These categories include both positive and negative aspects by the participants' point of views. The categories revealed as a result of analyses and the factors regarding these categories are given at the tables below.

Table 3. The findings revealed in the category "human health"

Category		Participants' point of views	
Human health		**Positive (f)**	**Negative (f)**
Decodings	Healthy production (Reliability)	3	7
	Preventing the diseases	1	--
	Knowing the content	2	2
	Lifting the obligation of antibiotic	1	--
	Protection from contagious diseases	1	--
	The problem of GMO	--	1
	Genetic modification	--	1
	Obesity	--	3
	Flavoring	--	1
	Nutritional value	--	1
Total		**8**	**15**

As it is seen at Table 3, the participants have both positive and negative point of views in terms of human health. However, it is noteworthy that the negative perspectives are more in this category. This finding shows that a more hesitant understanding is displayed when human health is involved. An important fact taking attention here is that there are different point of views for the same factors. For example, the participants present both positive and negative point of views on the healthy production and meat content. It is a conspicuous finding that the factors such as GMO and flavoring taking place in the socio- scientific issues are emphasized with negative point of views also in the issue of artificial meat. This finding can be interpreted as the indicator that the issue of artificial meat is related to socio-scientific issues. For example, some statements where positive and negative point of views are reflected as follows.

> *"Since artificial meat is hygienically produced in a laboratory environment, I think that diseases can be prevented."* ***(P26)***
> *"On the other side, I think its nutritional value and taste will be worse in comparison with natural meat. Because these change according to the ways of animal nutrition."* ***(P7)***
> *"I think that it is unhealthy and will get negative opinions because it is synthetic."* ***(P15)***

Also, an examples in which the participant reflects his/her point of views hesitatingly is as follows.

> *"I think its unreliability, taste, nutritional value, chemicals in it and religious dimension is very disputable. If we look at its positive impacts, they are not as efficient as its negative impacts, to me."* ***(P3)***

Table 4. The findings revealed in the category ''environment''

Category		Participants' point of views	
Environment		**Positive (f)**	**Negative (f)**
Decodings	Less environmental damage	3	--
	Low energy usage	2	--
	Less land usage	4	--
	Less greenhouse gas emission	4	--
	Less water usage	2	--
	Preventing the decrease of sources	2	--
	Decreasing of fertilizer	1	--
	Destroying ecological balance	--	1
	Greenhouse gas, food pollution is not excuse	--	3
Total		**18**	**4**

When examined Table 4, most of the participants have positive point of views regarding artificial meat's being beneficial to the environment, like the findings related to infographics. Indeed, ''destroying ecological balance'' as a negative point of view is an important question mark. Because even if there is not any study on this issue, this asserted negative point (when we think the ecological balance concerns all the world) may be more predominant than the other points. For example, some statements where positive and negative point of views are reflected as follows.

"While our water resources are already insufficient, artificial meat is a opportunity for us. We are a culture that have present the meat at the table. It is a good chance for the people who don't afford it." ***(P4)***

"At this time when we are more responsible for the environment, we can reduce environmental problems thanks to artificial meat." ***(P32)***

"It can be sought a solution for greenhouse gas, food pollution, the need of land with another method rather that seeing conventional meat so negative." ***(P8)***

Table 5. The findings revealed in the category "the need of food and its quality''

Category		**Participants' point of views**	
The need of food and its quality		**Positive (f)**	**Negative (f)**
Decodings	Fulfilling the need of meat	9	1
	The quality of taste and smell	2	8
	Fulfilling the need of protein	2	--
	Fast production	1	--
Total		**14**	**9**

When examined Table 5, it is possible to see that the participants have both positive and negative point of views again. When examining the factors here, it will be seen that different point of views are present for the same factors as it is in the category ''human health''. The remarkable point here is that the point of views towards the factors of ''fulfilling the need of protein'' and ''the quality of taste and smell'' are close to each other in inverse proportion way. Considering such a contrast as a matter of choice or decision-making in terms of relevant factors, the issue of artificial meat can be considered as an issue in the socio-scientific context. In addition, it is a fact that nutritional needs are more dominant than qualities such as taste and smell, and it provides a more positive perspective towards artificial meat. For example, some statements where positive and negative point of views are reflected as follows.

"Over time, its production will accelerate, so that more people who need food can be reached." ***(P2)***

"The resources are decreasing over years. The research and new researches should be present at every issue. I think artificial meat is the best and the most harmless of these resources." ***(P20)***

"I think that the taste and smell will not be like natural meat. I think it will be uniform since it is produced in a laboratory environment." ***(P23)***

Table 6. The findings revealed in the category "economy"

Category		**Participants' point of views**	
Economy		**Positive (f)**	**Negative (f)**
Decodings	Low cost	6	--
	Reducing foreign dependency	1	--
	Increasing population	1	--
	Unemployment	--	3
	Subsistence with animal husbandry	--	1
Total		**8**	**4**

An important finding revealed in the views of the participants are about the economic impact of artificial meat. Accordingly, when examined Table 6, it is seen that different point of views are present in terms of different factors. Even if the factors are categorized in terms of point of views, it is possible to see openly the participants have both positive and negative point of views. A contrast is

also seen in this category as well as in the category of "the need of food and its quality". So, the issue of artificial meat can be considered as an issue in the socio-scientific context within the frame of the category. In addition, it is a fact that low cost are more dominant than qualities such as unemployment, and it provides a more positive perspective towards artificial meat. For example, some statements where positive and negative point of views are reflected as follows.

"The cost of artificial meat decreases over time. This contributes to both production and consumption economically." ***(P9)***
"The resources should be increased because we are not able to reduce the population." ***(P21)***
"I think it will be better results if the budget allocated for the study is used with the aim of encouraging the people who are occupied with animal husbandry or livestock raising and spent for naturally meat production." ***(P28)***
"Unemployment may occur for people who are connected to the livestock sector with artificial meat production." ***(P36)***

Also, an examples in which the participant reflects his/her point of views hesitatingly is as follows.

"If artificial meat is produced in our country, the foreign dependency can be reduced. However, it can make a trouble for the citizen who earns a livelihood by animal husbandry." ***(P11)***

Table 7. The findings revealed in the category "culture"

Category		**Participants' point of views**	
Culture		**Positive (f)**	**Negative (f)**
Decodings	Religious belief	--	5
	Finding unethical	--	1
Total		**--**	**6**

When examined the findings in the category ''Culture'' taking place in Table 7, it is understood that the whole of the participants presenting a view about this issue have negative point of view. As a reason of this, it is possible to say that the factor of ''religious belief'' is predominant. For example, some statements where negative point of views are reflected as follows.

"Many region of our society may not find it necessary because of their religious belief. They may be nervous about the taste of the meat." ***(P10)***
"It may not be ethical depending on the cultures of the societies." ***(P12)***

Table 8. The findings revealed in the category "the protection of animals"

Category		**Participants' point of views**	
The protection of animals		**Positive (f)**	**Negative (f)**
Decodings	Reducing animal deaths	5	--
	Preventing improper practices	1	--
Total		**6**	**--**

As it is seen at Table 8, the whole of the participants who present a view on this issue look positively at the issue of artificial meat for the protection of the animals. As the reason of this situation, the factor of ''reducing animal deaths'' draws attention. For example, some statements where positive point of views are reflected as follows.

"When we think of it as animal lovers, it is a good development as animals will not die and we will meet our needs from artificial meat." ***(P17)***
"Improper practices to protect animals from diseases, such as wrong antibiotic supplementation, can be prevented." ***(P35)***

The positive and negative point of views of the participants are presented in tables categorically. When we analysis the statements regarding these point of views, we can see that the participants reflect their positive or negative point of views and sometimes hesitatingly (both positive and negative together). An important point that draws attention in the compositions is that although participants do not point out certain factors, it is understood that the participants are indecisive and hesitant about artificial meat. This finding can be seen as an indication that they have dilemmas in the issue. Some examples where the participants reflects their point of views hesitatingly is as follows.

"Its negative impacts which I learned yesterday while collecting data disinclined me. On the other side, I think it can be tried when I see its positive impacts and benefits." ***(P6)***

"It is not for me because the meats produced in the livestock sector where natural and organic production methods are used are healthy, but alternative meat production should be thought if a trouble is gone through in the meat stocks in the future." ***(P13)***

"I think artificial meat can be used but it should be sufficient and not exaggerated." ***(P19)***

"Moreover, I think whether a meat created from the stem cell will be accepted or not is another matter of debate. I think people will have many questions in their minds and their solvings will take a long time." ***(P24)***

"Finally, we can't know how it will affect the people, environment and society in the long term." ***(P27)***

4. DISCUSSION and CONCLUSION

In this study, the issue of artificial meat in the context of socio-scientific issue was analyzed from the perspective of preservice science teachers. When examining the findings obtained from both infographics and in written form, it is seen that the results are similar. The participants have both positive and negative point of views regarding artificial meat. However, it is possible to say that positive point of views are predominant. It is seen that the factors reflecting positive point of views are mostly environmental impacts besides health, economy and cost. This result corresponds completely to the factors related to the necessity of artificial meat revealed also in the literature (Bhat, Kumar & Bhat, 2017; Bonny et al., 2015; Mattick, Landis & Allenby, 2015; Moritz, 2017). Besides this, it is understood that few negative point of views regarding the same factors are present when examined in detail in the categories. For example, the issues of healthy production, the content of the artificial meat, ecological balance and unemployment are the most remarkable factors. It is understood that the factors reflecting negative point of views of the participants is mostly within the frame of social factors. For example, the factors such as taste, adjuvants like flavoring, religious belief, GMO and images come up as remarkable factors. This result corresponds completely to the factors stated in the literature regarding the acceptance of artificial meat (demographic factors, individual values and consumer perceptions) (Bonny et al., 2015; Bryant & Barnett, 2018; Grunert, Bredahl & Brunso, 2004; Phillips, 2017; Siegrist, 2008). The participants present hesitating point of views as well as reflecting positive or negative point of views. The factors stated above frequently take place in these controversial factors. However, a remarkable fact is that an unpredictable situation related to artificial meat is stated in the hesitating statements of the participants. Exaggerating on this issue, people's having questions in their minds which takes a long time to solve and not knowing its impact on people, environment and society in the long term can be exemplified. These views of the participants are similar to Mattick, Landis & Allenby's (2015) views that nearly many certainly unexpected results can arise besides the benefits of artificial meat. The participants (P8, P14 and P21) debate that the benefits shown as the result of artificial meat (preventing food pollution, reducing the need of land, reducing greenhouse gas etc.) can be solved with another methods. This result is similar to the issues stated by Bonny and et al. (2015).

Considering in the context of Socio- Scientific issues, we can see two results clearly in this study. Firstly, the findings show us that the participants express openly the controversial structure of the issue of artificial meat by making comparisons based on the data. The participants' expressions' being similar to the literature confirms their point of views. In other words, it is understood that they

have a literature-dependent perspective and they can present the dilemma about artificial meat by using the literature. This can also be taken into account as an indication that the data is directive. An important result comes up when taking into consideration both the findings obtained from the participants because of their being preservice science teacher graduated from science education and being educated in the context of socio- scientific issues, and the aspects that the socio- scientific issues contains in the literature (Ratcliffe & Grace, 2003). This result is that the issue of artificial meat can be evaluated as a Socio- Scientific issue. Secondly, the factors revealed in the findings related to artificial meat can be considered as factors which can be used in the education of artificial meat in the context of a socio-scientific issue. In this respect, the expression of the participant with code P30 "… if this issue is debated in the colleges as a socio-scientific issue, they will really learn the benefits of artificial meat, what it gains and how it affects our future." is remarkable. As it is stated by Bryant and Barnett (2018), longitudinal studies which provide us to observe how the manners change in time are of vital importance in the future. So, when it is considered that the developments related to artificial meat penetrate in our lives, it can be suggested to make different studies by evaluating this issue in the context of SSI for the education of the individuals who will form our future.

Acknowledgement

The data used in this study was confirmed by the researchers that it belongs to the years before 2020.

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