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THE HIERARCHY OF DECISION-MAKING CRITERIA FOR CHOOSING ORGANIC FOOD BY CONSUMERS ON THE EXAMPLE OF VEGETABLES AND FRUITS WITH THE USE OF THE APH METHOD

Summary

Intensification of agriculture is one of the threats to the environment. Large amounts of applied mineral fertilizers and chemical plant protection products cause soil pollution, as well as pollution of surface and ground waters. Some of the harmful substances get into the human digestive tract through plants and animals. Therefore, more and more people introduce organic food into the menu in the care of health and safety. Organic farming is both safe for the environment and it allows the production of food, which is free of impurities (residues of plant protection products).Consumers are increasingly demanding for quality food, so sale of organic products continues to increase. The aim of this study was to select and prioritize criteria of the decision-making process related to the selection of organic food on the example of vegetables and fruits with the use of the Analytic Hierarchy Process (AHP). For the purpose of the study, 20 consumers were surveyed to purchase organic food. They determined specific criteria that have (in their belief) a significant impact on the decision to purchase organic vegetables and fruits. Researches have shown that during the selection of organic food, consumers pay a lot of attention to the look and taste of the purchased products.
***Key words**: organic food, organic farming, decision-making process.*

HIERARCHIZACJA KRYTERIÓW DECYZYJNYCH WYBORU ŻYWNOŚCI EKOLOGICZNEJ PRZEZ KONSUMENTÓW NA PRZYKŁADZIE WARZYW I OWOCÓW Z WYKORZYSTANIEM METODY AHP

Streszczenie

Intensyfikacja rolnictwa jest jednym z zagrożeń dla środowiska. Duże ilości stosowanych nawozów mineralnych i chemiczne środki ochrony roślin powodują zanieczyszczenia gleby oraz wód powierzchniowych i gruntowych. Część substancji szkodliwych poprzez rośliny i zwierzęta dostaje się do ludzkiego przewodu pokarmowego. Dlatego też coraz więcej osób w trosce o zdrowie i bezpieczeństwo wprowadza do jadłospisu żywność pochodzącą z produkcji ekologicznej. Rolnictwo ekologiczne jest bezpieczne zarówno dla środowiska jak również pozwala na wytwarzanie żywności pozbawionej zanieczyszczeń (pozostałości środków ochrony roślin). Konsumenci są coraz bardziej wymagający, dlatego też sprzedaż ekologicznych produktów żywnościowych wciąż wzrasta. Celem pracy była selekcja i hierarchizacja kryteriów procesu decyzyjnego wyboru żywności ekologicznej na przykładzie warzyw i owoców z wykorzystaniem metody Analitycznej Hierarchizacji Procesu (Analytic Hierarchy Process - AHP). Dla zrealizowania celu pracy przeprowadzono badania wśród 20 konsumentów, którzy dokonują zakupu żywności ekologicznej. Określali oni kryteria szczegółowe, które ich zdaniem mają istotny wpływ na decyzję zakupu ekologicznych owoców i warzyw. Badania wykazały, że konsumenci podczas wyboru żywności ekologicznej zwracają dużą uwagę na wygląd i smak kupowanych produktów.
***Słowa kluczowe**: żywność ekologiczna, rolnictwo ekologiczne, proces decyzyjny*

1. Introduction

The food market in the world consists of three different groups, which (apart from differences in the production, labeling or distribution) are distinguished by the degree of security in terms of consumption. We can discriminate conventional, genetically modified and organic food [7]. Conventional food is focused on the intensification of production by reducing costs and increasing the efficiency of obtained agricultural crops with the use of mineral fertilizers and chemical plant protection products [7, 8, 21]. Genetically modified food is produced by the use of genetic engineering techniques in the production of food raw materials, through which genetic material is altered in a non-natural way. It involves the introduction of a gene or genes from other organisms to obtain specific qualities, such as resistance to pests, tolerance to herbicides, or improvements in chemical composition or sensory properties [7]. Genetically modified products interfere with the natural biological order. There has not yet been thorough examination concerning their effects on the environment and health of people and animals [23, 27]. Contrary to conventional food, organic food is strictly prohibited in the production of organic food, chemical fertilizers, synthetic fertilizers and GMOs, and products made or produced from them. It is produced on the basis of principles related to the sustainable plant and animal production in an organic farm, excluding the use of chemical plant protection agents and artificial mineral fertilizers. The production of organic food is connected with an increased cost of its creation, but it is undoubtedly more secure in consumption [2, 3, 6, 20].

An organic farm is a farm that which produce in accordance with the requirements of Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labeling of organic products, are under the control of designated certification bodies and their products are labeled accord-

ingly [9]. The beginnings of organic farming in Poland dates back to the 1930s. However, in the war and postwar period, there has been an intensification of agricultural production, and thus – inhibition of the organic method of farming. At the turn of the seventies and eighties, the idea of organic farming was restored [5, 9].

Interest in organic farming on a large scale in Poland it was in the early 2000s (in connection with the Polish accession to the European Union and the associated support for the organic sector in the framework of agri-environmental programs Rural Development Plan). Market analyzes show a clear increase in the demand for organic food in EU countries, so it may be assumed that the demand for organic food (despite the fact that the organic food market just begins to shape) will increase in the near future in Poland [9, 26]. Moreover, interest in organic farming is also connected with the increasing level of ecological awareness of society about the deteriorating state of the environment [22, 25].

2. Purpose, scope and methodology of researches

The purpose of this study is to identify a set of detailed and main criteria of the decision-making process for selecting organic food on the example of vegetables and fruits, compare them in pairs and rank them in accordance with a decreasing influence on the decision.

The importance of individual main criteria (including the weight of specific criteria) was determined with the use of a pair comparison method –Analytic Hierarchy Process (AHP). The AHP method is a heuristic approach developed by American researcher T. L. Saaty [15, 16, 17]. It combines elements of mathematics and psychology [1, 4, 11, 12, 24]. It facilitates to make optimum choices in the case of multi-criteria decision-making problems through their reduction to a series of pair comparisons, which are carried out by experts from a certain industry. As a result, it allows the determination of a numerical importance scale for the analyzed criteria [10, 13].

For the purpose of the work, researches among 20 randomly selected people, who decided to buy organic food, were performed. These consumers defined specific criteria that (according to them) have a significant impact on the choice of specific organic food. The detailed criteria were grouped into the main criteria. The total number of these second criteria, in accordance with the accepted research methodology, should oscillate within 5-9 criteria. Determination of boundary conditions, with regard to the number of criteria, helps to avoid the inconsistency of comparisons in pairs and it results from psychological experiments, according to which a single criterion cannot be simultaneously compared with more than 7±2 other criteria, because it hinders their distinction [14, 16, 18, 19].

At the next stage, the participants of tests assigned a specific number from the 100 point pool for each of the main criteria.

Designated marks form a matrix of comparisons K_{nn}, with a dimension $n \cdot n$, where n is a number of all the compared criteria. They are ranked successively in headings or rows and column of the matrix. It elements are estimations *aij*, entered at the intersection of the *i* line and *j* column, equation 1:

$$\begin{array}{c|c} & \begin{array}{cccccc} K1 & K2 & \dots & Kj & \dots & Kn \end{array} \\ \hline \begin{array}{c} K1 \\ K2 \\ \vdots \\ Ki \\ \vdots \\ K_n \end{array} & \left[\begin{array}{cccccc} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2j} & \dots & a_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{i1} & a_{i2} & \dots & a_{ij} & \dots & a_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nj} & \dots & a_{nn} \end{array}\right] \end{array} = K_{nn}, \tag{1}$$

where: *i, j = 1, 2, ..., n.*

Each pair comparison matrix should meet the condition 2:

$$a_{ij} = \frac{1}{a_{ji}}, \tag{2}$$

where: *i, j = 1, 2, ..., n.*

The raking procedure for the main criteria is connected with the normalization of matrix columns: $K_{nn} = \left[a_{ij}\right]$, to the matrix $\overline{K}_{nn} = \left[\overline{a}_{ij}\right]$, according to the record 3:

$$\begin{array}{c|c} & \begin{array}{cccccc} K1 & K2 & \dots & Kj & \dots & Kn \end{array} \\ \hline \begin{array}{c} K1 \\ K2 \\ \vdots \\ Ki \\ \vdots \\ K_n \end{array} & \left[\begin{array}{cccccc} \overline{a}_{11} & \overline{a}_{12} & \dots & \overline{a}_{1j} & \dots & \overline{a}_{1n} \\ \overline{a}_{21} & \overline{a}_{22} & \dots & \overline{a}_{2j} & \dots & \overline{a}_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ \overline{a}_{i1} & \overline{a}_{i2} & \dots & \overline{a}_{ij} & \dots & \overline{a}_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ \overline{a}_{n1} & \overline{a}_{n2} & \dots & \overline{a}_{nj} & \dots & \overline{a}_{nn} \end{array}\right] \end{array} = \overline{K}_{nn}, \tag{3}$$

where:

$$\bar{a}_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, \quad (4)$$

Next to, average values of criteria weights $\bar{w}_{K,ij}$ are determined in each row of the normalized matrix $\bar{K}_{nn}$, according to equation 5.

$$\bar{w}_{Kij} = \frac{\sum_{i=1}^{n} \bar{a}_{ij}}{n}, \quad (5)$$

where: *i, j = 1, 2, ..., n.*

As a result of the above calculations, the amount of different weights $\bar{w}_{Kij}$ among each main criterion depends on the numbers of peoples participating in the study. Therefore, it is necessary to determine the global weight $w_{K,i}$ for the criterion K_i, in accordance with equation 6:

$$w_{Ki} = \frac{\sum_{j=1}^{n} \bar{w}_{Kij}}{n}, \quad (6)$$

where:

$w_{K,i}$ - is a global weight of *i* criterion,

$\bar{w}_{Kij}$ - is a partial weight of – main criterion given by *j* participant of researches

n – a number of participants

3. Results and analysis of researches

As a result of the performed researches and ranking of the detailed criteria, the author obtained a set of hierarchical criteria from the main decision-making process related to the selection of organic food (Table 1). The order of placing the main criteria in the Table below and a symbol designation were random.

Table 1. Criteria for the decision-making process related to the selection of organic food

Tab. 1. Kryteria główne procesu decyzyjnego wyboru żywności ekologicznej

Criterion symbol *Ki*	Criterion name
K1	price of organic food
K2	appearance of organic food
K3	flavor of organic food
K4	seller recommendation
K5	opinions of other consumers
K6	distance to the point of sale
K7	quality certificates

Source: own work / Źródło: opracowanie własne

However, Table 2 provides the scoring assessment of the main criteria, which were referred to the hierarchy. Points were allocated by the participants. Each consumer allocated a certain number of points from a pool of 100 points. The "0" value in the scoring assessment was given by consumers to the main criteria, which were irrelevant in the selection process of organic food (in their opinion). On the other hand, "100" was given, when the selection was only based on one main criterion.

The individual scoring assessment for main criteria, carried out by each consumer, enables their prioritization (Table 3). The "=" sign express an equal level in the hierarchy of the analyzed main criteria, while the ">" describes their different levels. For consumer R1, the hierarchy of criteria is as follows: criterion K2, criterion K3, criterion K1 and behind them there are criteria K4, K5, K6 and K7, which are the least important criteria at the same time.

Table 2. Scoring assessment for the importance of the main criteria by the costumers (R)

Tab. 2. Punktowa ocena ważności kryteriów głównych przez badanych konsumentów (R)

No.	Evaluation of the main criteria importance						
	K1	*K2*	*K3*	*K4*	*K5*	*K6*	*K7*
R1	5,0	50,0	40,0	5,0	0,0	0,0	0,0
R2	0,0	50,0	50,0	0,0	0,0	0,0	0,0
R3	10,0	40,0	40,0	5,0	5,0	0,0	0,0
R4	25,0	20,0	15,0	15,0	10,0	10,0	5,0
R5	5,0	30,0	30,0	5,0	5,0	10,0	15,0
R6	0,0	100,0	0,0	0,0	0,0	0,0	0,0
R7	10,0	90,0	0,0	0,0	0,0	0,0	0,0
R8	10,0	70,0	10,0	5,0	0,0	0,0	5,0
R9	5,0	5,0	5,0	5,0	0,0	0,0	80,0
R10	5,0	25,0	10,0	35,0	10,0	0,0	15,0
R11	10,0	20,0	10,0	25,0	10,0	15,0	10,0
R12	15,0	15,0	55,0	0,0	5,0	5,0	5,0
R13	0,0	25,0	40,0	30,0	0,0	5,0	0,0
R14	0,0	35,0	35,0	15,0	15,0	0,0	0,0
R15	5,0	40,0	10,0	10,0	20,0	10,0	5,0
R16	20,0	35,0	0,0	0,0	0,0	20,0	25,0
R17	5,0	25,0	40,0	0,0	0,0	30,0	0,0
R18	0,0	90,0	10,0	0,0	0,0	0,0	0,0
R19	0,0	70,0	30,0	0,0	0,0	0,0	0,0
R20	5,0	45,0	25,0	10,0	10,0	0,0	5,0

Source: own work / Źródło: opracowanie własne

Table 3. The hierarchy of the main criteria
Tab. 3. Hierarchizacja kryteriów głównych

No.	Hierarchization of the main criteria
R1	*K2 > K3 > K1 > K4 = K5 = K6 = K7*
R2	*K2 = K3 > K1 > K4 = K5 = K6 = K7*
R3	*K2 = K3 > K1 > K4 = K5 > K6 = K7*
R4	*K1 > K2 > K3 = K4 > K5 = K6 > K7*
R5	*K2 = K3 > K7 > K6 > K1 > K4 = K5*
R6	*K2 > K1 = K3 = K4 = K5 = K6 = K7*
R7	*K2 > K1 > K3 = K4 = K5 = K6 = K7*
R8	*K2 > K1 = K3 > K4 = K7 > K5 = K6*
R9	*K7 > K1 = K2 = K3 = K4 > K5 = K6*
R10	*K4 > K2 > K7 > K3 > K5 > K1 > K6*
R11	*K4 > K2 > K6 > K1 = K3 = K5 = K7*
R12	*K3 > K1 = K2 > K5 = K6 = K7 > K4*
R13	*K3 > K4 > K2 > K6 > K1 = K5 = K7*
R14	*K2 = K3 > K4 = K5 > K1 = K6 = K7*
R15	*K2 > K5 > K3 = K4 = K6 > K1 = K7*
R16	*K2 > K7 > K1 = K6 > K3 = K4 = K5*
R17	*K3 > K6 > K3 > K1 > K4 = K5 = K7*
R18	*K2 > K3 > K1 = K4 = K5 = K6 = K7*
R19	*K2 > K3 > K1 = K4 = K5 = K6 = K7*
R20	*K2 > K3 > K4 = K5 > K1 = K7 > K6*

Source: own work / Źródło: opracowanie własne

By using the hierarchical layout of the main criteria presented in Table 3, the matrix of pair comparisons was created. The analysis was based on the rating scale indicated in Table 4.

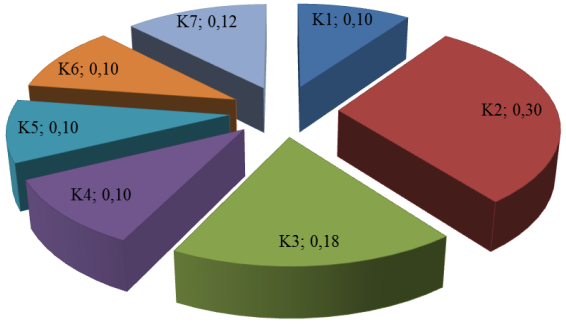
Table 5 show the values of partial weights for the determined main criteria. Each of them has as many partial scales as the number of users purchasing organic vegetables and fruits participated in the ranking. For the consumer R1, the most important is criterion K2 (with a weight of 0,36) – i.e. an appearance of organic food. On the other hand, for the consumer R9, the most important criterion (weight 0,54) is quality certificates (K7).

Table 4. Accepted scale of the process based on the comparison in pairs
Tab. 4. Przyjęta skala ocen procesu porównywania parami

Difference in scoring	rating
0-20	1
21-40	3
41-60	5
61-80	7
81-100	9

Source: own work / Źródło: opracowanie własne

Thanks to the use of equation 6 (presented in the methodology), values of global weights for the main criteria in the decision-making process related to the selection of organic food were determined. They are presented in Fig. 1. Criteria with the highest global weight are: the appearance of organic food (K2) – weight: 30% and the taste of organic food (K3) – weight: 18%. On the other hand, the lowest weights (10%) were obtained by the following criteria: K1, K4, K5 and K6 – i.e.: price of organic food, seller's recommendation, opinion of other consumers and distance from the point of sale.



Source: own work / Źródło: opracowanie własne

Fig. 1. Values of weights for the main criteria in the decision-making process
Rys. 1. Wartości wag kryteriów głównych procesu decyzyjnego

Table 5. Partial weights of the main criteria
Tab. 5. Cząstkowe wagi kryteriów głównych

No.	Partial importance of the main criteria						
	K1	*K2*	*K3*	*K4*	*K5*	*K6*	*K7*
R1	0,08	0,36	0,25	0,08	0,08	0,08	0,08
R2	0,07	0,33	0,33	0,07	0,07	0,07	0,07
R3	0,09	0,27	0,27	0,09	0,09	0,09	0,09
R4	0,14	0,14	0,14	0,14	0,14	0,14	0,14
R5	0,10	0,21	0,21	0,10	0,10	0,14	0,14
R6	0,07	0,60	0,07	0,07	0,07	0,07	0,07
R7	0,08	0,54	0,08	0,08	0,08	0,08	0,08
R8	0,08	0,51	0,08	0,08	0,08	0,08	0,08
R9	0,08	0,08	0,08	0,08	0,08	0,08	0,54
R10	0,17	0,16	0,12	0,18	0,13	0,11	0,13
R11	0,14	0,14	0,14	0,14	0,14	0,14	0,14
R12	0,10	0,10	0,41	0,10	0,10	0,10	0,10
R13	0,08	0,20	0,26	0,23	0,07	0,09	0,07
R14	0,10	0,21	0,21	0,14	0,14	0,10	0,10
R15	0,11	0,30	0,11	0,11	0,14	0,11	0,11
R16	0,14	0,21	0,10	0,10	0,10	0,14	0,21
R17	0,10	0,21	0,23	0,08	0,08	0,23	0,08
R18	0,07	0,60	0,07	0,07	0,07	0,07	0,07
R19	0,07	0,48	0,19	0,07	0,07	0,07	0,07
R20	0,11	0,29	0,16	0,11	0,11	0,10	0,11

Source: own work / Źródło: opracowanie własne

4. Conclusions

The performed researches and analysis of the obtained results enable to formulate the following conclusions.

1. Criteria concerning the appearance of taste of the products are the most important criteria in the decision-making process related to the purchase of organic food. This may point to the search of high quality food products.
2. Criteria that have the least impact on the choice of organic food are, inter alia, price and distance from the point of sale. This confirms high requirements connected with the quality of purchased food products.
3. The criterion related to organic food quality certificates reached a weight of just 12 %. This may indicate a lack of information and knowledge about organic food among consumers.

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