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Quantity and quality of poultry products depending on birds' rearing system

Ilość i jakość surowców drobiarskich w zależności od systemu chowu ptaków

Summary. The article discusses the influence of poultry rearing system on the quantity and quality of the obtained products, meat and eggs, also in the aspect of consumers preferences. Systems characterised by various levels of intensity were considered. It may be concluded that the characteristics of products' quality (nutritional, hygienic, sensorial and technological ones) do not vary considerably between the production methods. In some traits organic poultry products are better, in others, conventionally produced ones are superior. It seems that the popularity of the organic system of poultry rearing depends more on consumers' knowledge about birds' welfare, their belief in beneficial characteristics of such a kind of products as well as family income because a higher price is the most important factor affecting the purchasing choices.

Key words: rearing system, eggs quality, meat quality, production effects

INTRODUCTION

The system of rearing is the most complex factor modifying the quantity and quality of poultry products. It is composed of environmental conditions, such as light programme, temperature, ventilation and relative humidity, as well as feed nutritive value. Each of these elements, taken together or separately may constitute an optimal opportunity for poultry production or become a stressor causing health problems and decrease the quantity of the raw material. Poultry production underwent rapid changes during the past decades because of the introduction of modern intensive production methods, new hybrids and improvement in preventive disease control and bio-security measures [Mack 2005].

Most of poultry raw material is obtained from intensive rearing system. However, modern consumers all over the world, especially in European Union, started to be inter-

ested in the source or origin of poultry products. They started to pay attention to the welfare of birds, their rearing conditions as well as safety and quality of meat and eggs. Generally, consumers of organic products (vegetal and animal) are convinced of their beneficial properties and much better quality in relation to traditionally produced ones [Pavlovski *et al.* 2009, Lairon 2010]. Also organic farms are considered to be more profitable than others.

Interestingly, higher productivity of the intensive system and much better feed conversion ratio, compared to the extensive one, are seemed to potentially reduce the environmental impacts (per 1000 kg of eggs) of poultry production [Leinonen *et al.* 2012]. In addition, rearing or runaway birds are more likely to contribute to the emission of gaseous pollutants such as ammonia or methane compared to uncrowded cage culture [Xin *et al.* 2011].

We would like to try to conclude, on the base of references, if these convictions or advantages of less extensive rearing methods are beneficial in case of birds' health status, but first of all, if they allow obtaining satisfactory amount of poultry raw materials characterised by good quality traits. Two types of domestic birds can be distinguished: meat- and laying-type. Both of them should be analysed separately.

MEAT-TYPE POULTRY

Poultry meat is the fastest growing component of global meat production, consumption and trade [Mack 2005]. Its source is mostly chickens and turkeys but also guinea fowls, ducks, geese, Japanese quails or ostriches. The success of the poultry industry has been fuelled by the ability to economically produce acceptable products [Anthony 1998]. However, for several decades it had been practised on industrialized farms. This enabled high-volume production and profitability resulted in a high production level and the overall volume of production reaching maximum limits of poultry biological potential and maximum consumption [Bogosavljevic-Boskovic *et al.* 2011]. Birds are reared on floors covered with litter. Throughout their life they have free access to automatically distributed feed and water. The cycle lasts from 40 to 60 days, depending on the sex and carcass size requested by the market as well as birds are slaughtered at live weights ranging from 1.7 to 3.5 kg. The stocking density in the hen house is directly related to the target final body weight [Meluzzi and Sirri 2009]. This industrial production may influence negatively birds' health. Their high growth rate with unequal development of the whole organism often leads to many disorders such as sudden death syndrome, ascites, chest blisters and legs illnesses i.e. bones degeneration [Reiter and Bessei 1998]. The intensive maintaining system limits birds from expressing their natural behaviour, greatly reducing their welfare.

The conventional livestock farming has been successful at increasing the performance of farm animals and decreasing the cost of production. At the same time the number of consumers who are willing to pay higher prices for the guarantee of organically grown animal products increases. The organic agriculture depends on the consumers' demands for organically produced products and for the added values such as biodiversity, species preservation, protection of nature or of animals [Sundrum 2001]. Consumers look for good quality products and they are ready to pay extra cost. In case of meat-type poultry

the quality of the obtained product is very variable. The quantities as well as technological traits depend on many factors. The main one is genotype, of chicks. The bird's genotype has a major impact on the productivity of the poultry. It significantly modifies the final weight of chickens, the proportion of particular carcass elements as well as the weight and proportions of edible giblets [Shahin and Elaze 2005, Ojedapo *et al.* 2008].

The production of poultry meat is based on fast-growing birds. Their carcasses are characterized by: maximum proportion of muscle, minimum proportion of bone and optimum proportion of fat dictated by specific trade preference. Also they must contain high proportion of breast and thigh muscles [Shahin and Elazeem 2005]. However, birds reared for longer time (at least 81 days) are considered as more tasty because of better slaughter maturity [Batkowska *et al.* 2014] and better taste [Grashorn and Serini 2006]. As it was mentioned before, in conventional farming fast-growing chicks are generally used, but they are not suitable for longer, less intensive production, since they may develop health and welfare problems. There is also a belief that under extensive breeding conditions, birds are unable to fully utilize their genetic potential and their growth is limited by deficient feeding [Gondwe and Wollny 2005]. Conversely, the use of slow-growing strains in extensive systems has positive repercussions on both animal welfare and product qualitative characteristics (eating quality and appearance) perceived by consumers [Castellini *et al.* 2008]. In reality for organic or free-range conditions mostly birds selected for high growth rate and good feed conversion under intensive conditions originate from commercial suppliers are used. It results from the fact that obtaining slow-growing strains is difficult and expensive [Castellini *et al.* 2002a]. All in all, in case of meat production the success is a resultant of both factors: genotype and rearing system.

Some experiments point that the free-range access causes a reduction in body weight and production efficiency as well as increases the mortality of birds [Połtowicz and Doktor 2011]. In some opinions the production effects of birds should be considered as a reaction of particular genotype for not optimal, extensive conditions. In some works indeed birds kept extensively, regardless of growth rate, achieved smaller body weight [Branciarri *et al.* 2009, Batkowska and Brodacki 2012]. But in some of them fast-growing birds fed with farm fodders and kept with access to green paddocks were considerably heavier than control groups, reared in conventional, litter system [Batkowska *et al.* 2015]. Also dissection parameters, such as proportions of valuable elements (breast muscle) may be better in carcasses of birds reared in extensive than in intensive system [Castellini *et al.* 2002b]. However, just outdoor or indoor rearing (access to green paddocks) may not influence dissection results [Bogosavljevic-Boskovic *et al.* 2006, Mikulski *et al.* 2011] or abdominal fat content [Michalczuk *et al.* 2013]. It should be connected also with various feeding systems. Feed with lower protein and energy concentrations may not fully meet the nutritional requirements of fast-growing chickens and results in smaller breast muscle proportion [Gordon and Charles 2002], whereas carcasses of birds which had access to runs and were fed additionally with green fodders were characterised by smaller proportion of thighs [Shanin and Elazeem 2005]. Free range system may decrease abdominal fat content in carcass [Baeza *et al.* 2001] but its proportion depends considerably on the final body weight of chicks. Heavier, fast-growing birds had bigger fat pad than lighter, slow-growing ones [Wang *et al.* 2009].

As quality traits of meat colour, water holding capacity, drip or cooking loss may be mentioned but also chemical composition of meat or sensorial characteristics (smell,

juiciness, tenderness). It can be stated that fast growing chickens are characterized by darker colour of breast muscle than slow growing chickens [Pietrzak 2013] also breast and thighs muscle of chicks kept with access to paddock were darker than from those birds reared under conventional, intensive conditions [Mikulski *et al.* 2011]. Better ability to keep water in meat, especially after thermal processing, was found in slow growing than in fast growing chickens [Owens *et al.* 2006, Pietrzak 2013]. Tenderness of meat is connected with motor activity of birds. It has been found that slow growing birds spend more time on paddock, actively foraging, whereas conventional broilers do not use the open space so often. On the paddock they agglomerate into groups close to feeders or the hen house, rarely foraging [Fanatico *et al.* 2006]. Active behaviour stimulates fibres of muscles to work and finally meat seems to be more firm. However, in some research differences in meat tenderness were not found in case of various rearing systems [Fanatico *et al.* 2005] or even birds reared under intensive conditions (with limited possibility to move) were characterised by higher values of shear force [Batkowska *et al.* 2015].

Based on the sensory analysis of chickens found that consumers prefer the meat of slow-growing bird than conventional broiler chickens [Castellini *et al.* 2002b]. Some authors reported that the sensory characteristics of the meat are more influenced by the birds' genotype than the system of their rearing. They may be affected by the rearing length [Fanatico *et al.* 2007]. Not only technological or sensorial traits of meat are important for consumers but also the possibility to recognize carcasses or meat derived from various systems of rearing. And again such kind of features i.e. willow skin colour or elongated carcass shape depend on both: genotype of birds and their feeding methods [Batkowska *et al.* 2014]. Skin colour plays a very important role in the consumers acceptance of poultry carcasses. Carotenoids, especially fat-soluble xanthophylls are responsible for its occurrence [Castañeda *et al.* 2005]. Their primary source for poultry is feed of plant origin (cereal grains, green plants) or synthetic dyes added to balanced feed mixture used in conventional system.

An important reason for the poultry meat consumption is its nutritional value, which also depends on the rearing system and feed mixture composition. Higher content of dry matter, protein and crude ash is characteristic for meat of birds derived from organic farming [Grashorn and Serini 2006]. But also higher content of these components was found in slow growing birds (kept for longer time), but a significantly lower content of fat was also noticed in these birds' meat in comparison to meat from conventional broilers [Berri *et al.* 2005]. The breeding system had an impact on the fatty acid profile in meat. The higher proportion of polyunsaturated acids was found in groups fed with green fodders, it resulted from an increased proportion of both n-3 and n-6 acids [Batkowska *et al.* 2011]. Considerably lower level of saturated fatty acids was demonstrated in breast muscle of fast-growing chicks reared with access to green runs [Kralik *et al.* 2005].

LAYING-TYPE POULTRY

The production of table eggs is an important part of the total poultry production. The most popular species in poultry are hens (*Gallus gallus*). Products obtained from these birds have the highest acceptance among consumers. This species is also most often used

as table eggs layers. According to the data of the Central Statistical Office of Poland in 2016 hen eggs production amounted to 10 599.6 thousand tons [GUS 2017].

Such a high level of production was possible primarily through the intensification and diversification of laying hens rearing systems. According to Commission Regulation (EC) No 589/2008 of 23 June 2008 consumer may choose eggs from the preferred main-taining system. It should be noticed that at the same time the consumer's knowledge about of the differences between farming systems is often limited. Nevertheless, this directive introduced individual marks for eggs obtained from organic, free range, litter and cage systems. Eggs derived from these systems vary considerably depending on the intensity of rearing [Krawczyk and Gornowicz 2010].

The quality of table eggs may depend on many factors ranging from the bird's genotype and age [Zita *et al.* 2009, Sarica *et al.* 2012], environmental and feeding conditions [Safaa *et al.* 2008] to rearing system of hens [Đukić-Stojčić *et al.* 2009, Batkowska *et al.* 2017]. Certain aspects can be modified to obtain the best possible raw material. Proper mating allows having hybrids with appropriate production characteristics. In addition, the possibility of intended changes in the lighting program in the hen house not only controls the quantity and quality of eggs, but it can also substantially facilitate the logistic collection of eggs, because of the possibility to estimate when, during the lighting day, the egg production is the biggest [Tůmová *et al.* 2007].

Egg quality assessment is based on a number of parameters to classify eggs into particular classes, not only because of the mass or presence of dirt shells (disqualifying eggs from A class), but also the depth of the air cell or colour and yolk index. It was shown that significant differences in egg quality parameters such as shell thickness and weight or yolk colour intensity depend on the farming system [Mugnai *et al.* 2009]. The comparison of eggs obtained from hens kept in organic system (with access to green rans and fed with and carotene-rich fodder) and from conventional cage system showed higher values of the yolk colour in the more intensive group, which may be due to the addition of synthetic dyes [Rossi 2007]. The yolk colour is a one of qualitative features that is one of the consumers' basic criteria for egg choice. Generally, darker egg yolks are preferred by consumers. Similar relations are observed with respect to the egg shell colour [Karunajeewa *et al.* 1984, Biesiada-Drzazga and Janocha 2009]. However, the shell is the first barrier to protect the interior of the egg against the influence of the outside environment is protected by a number of legal regulations in terms of quality. Regulation No 589 clearly states that eggs marketed as table eggs must have a clean shell without visible cracks or deformations. This is very important for food safety, because any damage or dirt can be a cause of microbial contamination. The quality of hen's egg shell depends mostly on a balanced and calcium-rich diet, but rearing conditions may also affect shell quality [Roberts 2004]. In the open hen house (without cages) eggs and their shells may be exposed to both mechanical damage and dirt coming from litter. This is a serious problem, especially in systems where application of full mechanization in egg collecting is difficult or even impossible (free range, organic).

Prices of raw materials, such as eggs, strictly depend on their mass and freshness. The depth of the air cell is considered as the main noticeable parameter of table eggs. It arises due to the temperature difference between layer's body and environment. The best quality (class extra) is attributed to eggs in which the air cell is not deeper than 4 mm [Commission Regulation No. 589/2008]. Under strictly controlled environmental

conditions, in intensive farming systems, the producer is able to meet these requirements. Unfortunately, in more extensive systems, this cannot be achieved due to changeable temperature conditions. This becomes a major handicap, primarily due to the fact that the air cell is deeper than 6 mm disqualifies the obtained eggs from A class. In the context of the relationship between the quality of eggs and the rearing system, the ability to standardize conditions in intensive systems also allows to produce the raw material, which is much more stable during the storage [Batkowska *et al.* 2016].

It was shown that high bird density per unit area causes stress and behavioural disturbances that can lead to productivity decrease [Campo *et al.* 2005]. Also the laying period was higher in intensive than in extensive rearing system [Arbona *et al.* 2009, Lukanov and Alexieva 2013]. It was also concluded that maintaining system does not affect the age of maturity by laying hens [Petek 2004]. In other research conventionally kept layers were matured approximately 2 weeks earlier than birds reared extensively, however, they reached the maximum production period approximately at the same time [Gerzilov *et al.* 2012].

Large-scale eggs production is based not only on the obtaining of a full-fledged material, but on satisfying the market needs with animal origin products. In this context, besides obvious characteristics affecting purchasing decisions of consumers or qualitative traits of the raw material, the productivity of the flocks resulted from both genotype and rearing system of birds is also important. Not without significance is the consciousness of customers who are more often guided by the animals' welfare than higher price of products from extensive farming. In 2016 the productiveness of laying hens decreased by 1.8%, it may be the first sign of a change in poultry production [GUS 2017]. However, it is noteworthy that extensive production is connected with some disadvantages compared to conventional production i.e. the increase of costs due to reduction of birds' stock density. Intensively selected hybrids do not quite fit in society's trends, resulting in lower productivity and not fully utilizing their production potential. Alternatively, crossbreeds of native breeds suitable for extensive breeding conditions may become available. Systems vary considerably in terms of the number of collected eggs as well as the age at which birds reaching the peak of laying production. This may be due to both the lack of standardized environmental conditions and the differences in daylight hours. It should be pointed that native birds or hybrids based on local breeds in the extensive system showed higher productivity compared to commercial strains. This gives a real possibility to increase the population of local breeds as birds dedicated to extensive farming [Rizzi and Marangon 2012, Batkowska and Brodacki 2017].

SUMMARY

Environmental conditions in the henhouse should provide birds the good health status resulted from limited harmful microbial development and exposition to infectious diseases. From other side birds kept on the runs may be exposed to greater risk of bacterial or viral infections. Extensive poultry production, regardless of birds, generates higher costs of rearing. To obtain satisfying income producers must sell their products at a higher price. It may be the factor limiting consumer to buy products derived from alternative systems of rearing [Van Loo *et al.* 2010].

It may be concluded that the characteristics of products quality (nutritional, hygienic, sensorial and technological) do not vary considerably between the production methods. In some traits organic poultry products are better, in others, conventionally produced ones. It seems that popularity of organic system of poultry rearing depends more on consumers' knowledge about birds welfare, their belief in beneficial characteristics of such a kind of products as well as family income because price is the most important factor affecting purchasing choices.

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Streszczenie. W artykule przedstawiono wpływ systemu chowu drobiu na ilość i jakość pozyskiwanych surowców, mięsa i jaj, również w aspekcie preferencji konsumentów. Uwzględniono systemy charakteryzujące się różną intensywnością utrzymania ptaków. Można stwierdzić, że cechy jakościowe surowców (wartość odżywcza, wskaźniki higieniczne, sensoryczne i technologiczne) nie różnią się znacznie w zależności od zastosowanych metod chowu. Pod względem niektórych cech lepsze są produkty drobiarskie pozyskane ekstensywnie, pod względem innych parametrów te pochodzące z chowu konwencjonalnego. Wydaje się, że popularność ekstensywnego systemu utrzymania drobiu zależy od stanu wiedzy konsumentów na temat dobrostanu ptaków, ich przeświadczenia o lepszych właściwościach produktów pochodzących z tego systemu oraz od dochodów rodziny, ponieważ cena jest najważniejszym czynnikiem determinującym wybory zakupowe.

Słowa kluczowe: system chowu, jakość jaj, jakość mięsa, efekty produkcyjne

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