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Review article

Agnieszka KORPAL, Katarzyna WOŹNIAK, Arkadiusz TERMAN

SELENOPROTEIN P GENE (*SEPP1*) AS A SELENIUM MARKER CONCENTRATION

GEN SELENOBIAŁKA P (*SEPP1*) JAKO MARKER KONCENTRACJI SELENU

Department of Genetics and Animal Breeding, West Pomeranian University of Technology Szczecin, Poland

Streszczenie. W dzisiejszych czasach właściwie zbilansowana dieta jest uznawana za jeden z najważniejszych czynników warunkujących ludzkie zdrowie. Zdrowe żywienie powinno opierać się na dwóch równorzędnych czynnikach – na prawidłowej diecie i na wysokiej jakości pokarmach. Wysoką jakość żywności odzwierciedla zawartość substancji mających pozytywny wpływ na organizm człowieka, np. witamin, substancji mineralnych (makro- i mikroelementów). Jednym z niezbędnych mikroelementów jest selen, który występuje w dwóch niezwykle ważnych aminokwasach – w selenocystinie i selenometioninie. Aminokwasy te wchodzą w skład białek nazywanych selenobiałkami, które odgrywają kluczową rolę w prawidłowym funkcjonowaniu organizmu człowieka. Stwierdzono, że ponad 95% mieszkańców Polski ma zbyt niski poziom selenu. Deficyty selenu, występujące w organizmach większości Polaków, można niwelować poprzez zapewnienie jego odpowiedniej podaży w diecie. Mięso od najdawniejszych czasów stanowi podstawowy składnik pożywienia człowieka. Najczęściej spożywanym przez konsumentów rodzajem mięsa w Polsce jest wieprzowina, co stanowi około 60–70% całkowitego spożycia mięsa w Polsce. Aktualnie mięso wieprzowe jest analizowane pod kątem polimorfizmów genów, których produkty białkowe mają istotne znaczenie dla jakości mięsa. Jednym z istotnych białek jest selenobiałko P (SeP). W odniesieniu do tych danych celowe wydaje się poszukiwanie funkcjonalnych polimorfizmów w genie kodującym selenobiałko P. Otrzymane wyniki pozwolą w przyszłości na selekcję zwierząt o oczekiwanym wariancie genetycznym, których mięso charakteryzować się będzie zwiększoną naturalną zawartością selenu.

Key words: selenoprotein P, polymorphism, meat quality.
Słowa kluczowe: selenobiałko P, polimorfizm, jakość mięsa.

INTRODUCTION

Nowadays having a right diet is considered to be one of the most important aspect of lifestyle and conditioning health of a person. The perception of human nutrition, especially in high developed countries, has changed significantly. Food is no longer perceived only as a source of nutrients, designed to cover the appropriate nutritional needs of man, but the attention is also focused on its functional properties, and thus the capability of a positive impact on the human body. Food's health benefits raise the increasing interest of both

Corresponding author – Adres do korespondencji: Arkadiusz Terman, Department of Genetics and Animal Breeding, West Pomeranian University of Technology, Szczecin, Piastów 45, 70-311 Szczecin, Poland, e-mail: arkadiusz.terman@zut.edu.pl

consumers and food producers. The emphasis on beneficial health attributes of food is caused by the increased interest in food quality. The proper nutrition is an integral part of the ecological lifestyle. (Li et al. 2005). People more and more often are several increasing seeking of healthy food, which is also called "functional food". This kind of food contains known biologically-active compounds which when in defined quantitative and qualitative amounts provides a clinically proven and documented health benefit, and thus, an important source in the prevention, management and treatment of chronic diseases of the modern age e.g.: obesity, atherosclerosis, diabetes or cancer (Martirosyan and Nicolson 2011).

Healthy eating should be based on two paralelly important factors: correct diet and high food quality. The high quality of food is characterised by the high level of substances having positive effect on an organism, that is vitamins and mineral supplements (macro- and microelements).

THE ROLE OF SELENIUM IN HUMAN ORGANISM

Selenium (Se) is an essential microelement, necessary for normal functioning of human body. In the past few years the role of selenium is the major subject of scientific research in many fields of science. Se is an important microelement, which is present at extremely low concentrations in bacteria, animals, and humans. Selenium is not only able to increase the general resistance of the organism to biopathogens, but also exerts a protective effect against certain oncological diseases and even immunodeficiency (Blicharski 2013).

The protective effect of selenium in animal cells is accounted for by some proteins whose active center contains socalled selenium amino acids (selenocysteine (SeCs) and selenomethionine (SeMet)) – Kuznetsov et al. (2003).

The mentioned amino acids are indispensable and play a key role for enzymatic proteins (Navarro-Alarcon et al. 2008). These proteins are powerful antioxidants. Biological functions of selenium are determined by selenoproteins that contain selenocysteine (the 21st aminoacid) in their primary structure. Selenocysteine is synthesized and inserted into proteins cotranslationally by a complex process (Burk et al. 2003). Among the proteins which include selenium (selenoproteins) the most important include glutathione peroxidase (Gpx), thioredoxin reductase (TXNRD), iodothyronine deiodinase (DIO) and selenoprotein P (SeP). These enzymes can be found in many types of cells and they have influence on i.e. capture, degradation and blocking of free radicals, thanks to these they protect the cells from damage, distortions of metabolism, or premature old age. The compounds of this element play an important role in neutralising and disposing of different toxic substances from an organism, and also regulating the process of apopthosis (Brown and Arthur 2001; Fairweather-Tait et al. 2011). Recognition of the important role of selenoproteins in metabolism helps to explain the adverse consequences of selenium deficiency in human health. The shortage of selenium in people diet makes the enzymes, which need it in the binding process, impossible to be synthesised or functionally deprived due to the lack of the element. For this reason the insufficiency of selenium in an organism can cause disorders on many levels of its functioning (Brenneisen et al. 2005).

The recommended dietary allowances (RDA) of selenium, which is considered as indispensable to maintain good health, equals 50–70 μg, that is approximately 1 μg per kilogram (Zwolak and Zaporowska 2005). Human dietary intakes also range from high to low according to geography. The suggested daily amount of selenium can be supplied with diet more easily in regions and geographical areas, which soil is characterised by a relatively higher amount of the element in question; it does not include soil within Poland's territory (Rayman and Phil 2000; Wierzbicka et al. 2007). Recognition of the important role of selenoproteins in metabolism helps to explain the adverse consequences of selenium deficiency in human and animal health (Wasowicz et al. 2003). There is evidence that less-overt selenium deficiency can have adverse consequences for disease susceptibility and the maintenance of optimal health. Low selenium status may contribute to the etiology of the disease process (e.g.: cancer, heart disease, immune function, asthma, male infertility, rheumatoid arthritis) but in some cases it may be an outcome of the condition itself and may exacerbate disease progression (e.g.: HIV infection) (Rayman and Phil 2000; Fairweather--Tait et al. 2011). It is confirmed that over 95% of the people living in Poland are lacking selenium in their diets (Jaworska et al. 2011). Selenium shortage that is present in bodies of most Poles is to be reduced by ensuring its supply in appropriate diet intakes.

PORK AS A RICH SOURCE OF SELENIUM

From the earliest times, meat is a basic nutritional component for humans. The kind of meat that is consumed most often in Poland is pork. Acording to the data from Główny Urząd Statystyczny (*Head Office of Statistics*) in 2012 a Pole ate yearly about 71 kg of meat and giblets with about 39,2 kg of pork within the number (Blicharski et al. 2013). Pork is a very valuable source of nutritional substances for a human being. The varieties in which this resource is present enables us to shape its quality and to offer a wide range of pork-based products. There is, however, a requirement of control and analyses of many factors which encompass genetic, environmental and preparational interactions. The interaction of these aspects has got a crucial influence on the final quality of the raw material. When one knows which factors influence the quality of pork meat and has the possibility of identifying them (e.g. estimation of polymorphisms), or of conducting them, it could be expected that the quality of the material in question will be answering the needs of consumers' expectations connected to the elevation of health and nutritional qualities of the product.

These days pork is being analysed from its genetic polymorphism perspective which protein products have crucial meaning for quality of the produced meat. One of the essential proteins is selenoprotein P (SeP), which has been identified as the first protein with the intake of more than one Se atoms in the form of molecular Sec. Nine residues are located in the C-ending of the molecule (between 281 and 358 aminoacidic residue), however no.10 in the position 40. SeP is a protein rich in histidine (23 residue), which presence is conditioned by its ability to bind with heparin. This characteristic feature is used during the isolation process of this selenoprotein (Saito and Takahashi 2000).

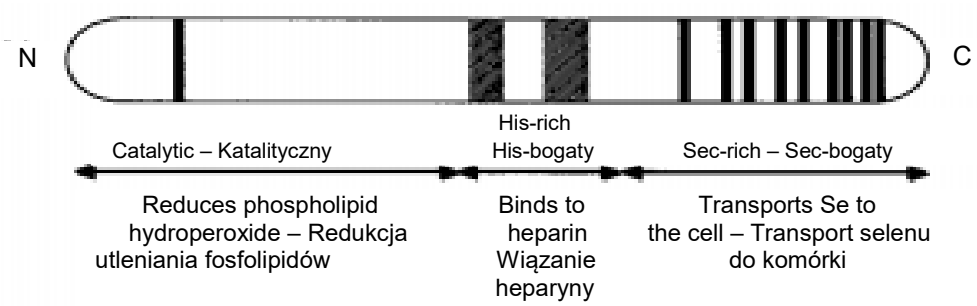

Fig.1. The structure of selenoprotein P domain and its functions. Vertical lines indicate Sec remainders and the parts of grey shading in the middle present the places rich in histidine
Ryc. 1. Struktura domeny selenobiałka P oraz jej funkcje. Pionowe linie prezentują położenie selenocysteiny (Sec), natomiast zacienione obszary przedstawiają regiony bogate w histydynę
Source – Źródło: Saito and Takahashi (2000).

THE SELENOPROTEIN P

Selenoprotein P is one of two known extracellular selenoproteins. Its concentration in plasma is sensitive to the selenium nutritional status of the individual, making it a useful biomarker of selenium status. Measurement of selenoprotein P in human plasma has shown that it is depressed by selenium deficiency and by cirrhosis. Selenium supplementation of selenium-deficient human subjects showed that glutathione peroxidase activity was optimized before selenoprotein P concentration was optimized, indicating that plasma selenoprotein P is the better index of human selenium nutritional status (Burk and Hill 2005). Selenium deficiency causes the selenoprotein P concentration to fall and the plasma selenium concentration to fall below 8 µg/dL (Burk et al. 2011). It is also a part of the process of selenium's transport from the plasma to cells. This supplies the body with the microelement crucial for the synthesis of selenoproteins and also functions as an antioxidant. The transport function is confirmed by the high intake of selenium in this particular protein and its extracellular location. The relationship between selenoprotein P with the cells of vascular endothelium in rats' liver, brain and kidneys has been confirmed. The substance is secreted to blood by the cells of liver parenchyma and it is directed towards almost every tissue within an organism (Burk et al. 2003; Włodarczyk and Birkle 2010). This gene coding the selenoprotein P (*SEPP1*) has been mapped on porcine chromosome 16 and contains 5 coding regions (NCBI, Gene ID: 100037964).

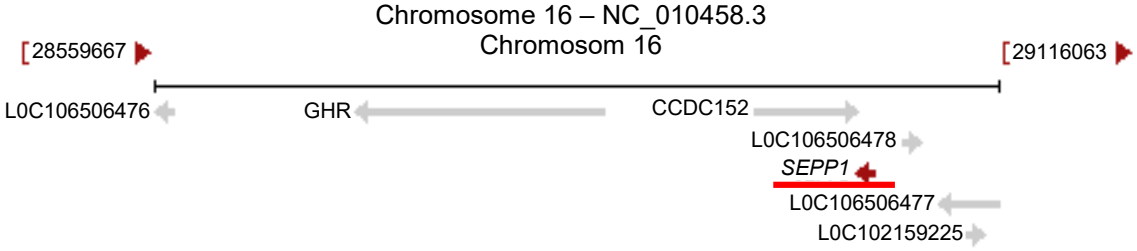

Fig. 2. *SEPP1* gene location on chromosome 16 in pigs
Ryc. 2. Lokalizacja genu *SEPP1* na chromosomie 16 u świń
Source – Źródło: SELENOP selenoprotein P, http://www.ncbi.nlm.nih.gov/gene/?term=chromosome+16+pig+sepp1, access: October 2015.

CONCLUSION

In the scientific research and in the application of the science, there is a lot of attention put towards the description of conditions and possibilities of advantageous modification of animal food's nutritional quality paying special attention to consumers' demands even in the phase of the raw material preparation. Methods of molecular biology have enabled the acquirement of high-nutrient and health-promoting pork, what fulfills the functional food criteria. In the future, there is a possibility of developing a complex pork producing technology, having functional food attributes and with gastronomic and product-preparing intention. In the light of the abovementioned facts it seems to be the aim to research for functional polymorphisms in the gene coding selenoprotein P. The calculation of selenium concentration in animal tissues will enable to determine the relation between particular genotypes and the content of selenium in the tissues of choice. The results will allow for the future selection of animals with the "expected" genetic variations, which meat would be characterized by the magnified content of selenium. This will permit the production of health-promoting food.

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Abstract. In these days having a right balanced diet is known to be one of the most important factors conditioning health of a person. Healthy eating should be based on two paralelly important elements: correct diet and high food quality. The quality of food is characterized by the high level of substances having positive effect on an organism, that is vitamins and mineral supplements (macro- and microelements). One of the essential trace element is selenium. Selenium is a component of the unusual amino acids selenocysteine and selenomethionine. Both of them are part of the proteins, the so called selenoproteins, which play a crucial role in a human health. It is confirmed that over 95% of the people living in Poland are lacking selenium in their diets. The shortage of selenium could be reduced by ensuring its supply in appropriate diet intakes. From the earliest times, meat is a basic nutritional component for humans. Pork, among other types of meat, has the highest consumption percentage in Polish population. Searching for polymorphisms, which occur in genes coding for proteins crucial in meat quality, is one of the most common research nowadays. One of the important protein is selenoprotein P (SeP). Considering all the above, it seems to be essential to detect functional polymorphisms in selenoprotein P gene. Obtained data will allow in the future for animal selection of a preferable genotype, with a naturally higher selenium content.