Abstract

The health of every organism depends on the quality of food being a source not only of the essential nutrients but also other compounds exerting both positive and negative effects. The immune processes comprising precisely regulated mechanisms including numerous neuroendocrine and immune cells belong to those the most susceptible to the dietary factors. Among substances with the positive effects on the immune system functions are microelements, antioxidants, and many other plant secondary metabolites. Negative effects are exerted mainly by the contaminants of the environmental origin, like heavy metals, mycotoxins and pesticide residues, presence of which in food may cause an immunodeficiency and many diseases. It is known that the food composition depends on the agricultural practices. Comparing to the conventional crop production, the use of natural fertilisers and plant protection in the organic agriculture increases the content of positive and decreases the amount of negative compounds. However, it has been already evidenced that the absence of chemical crop protection may cause an increase in the level of harmful myco- and bacterial toxins. Regardless of many studies comparing the composition of crops from conventional and organic agriculture or the health effects of their consumption, there is still only a few published experiments focusing on immune system function.

The aim of this study was to investigate an association between agronomic practices and the basic haematological parameters, the immune system status and the experimental inflammation process in rats fed with feeds prepared from conventionally or organically protected and fertilised crops.

The study lasting three vegetation seasons was conducted on male Wistar rats kept from weaning on experimental feed and water available ad libitum. The cereals (wheat in the 1st and 3rd year, barley in the 2nd year) and vegetables (potatoes, carrots and onions) used to produce animal feeds were grown in the experimental plots at Newcastle University farm in the UK, established for the large European research project. Crops were cultivated with two contrasting crop protection regimes (pesticide-based protocols used in conventional farming or crops protection according to the organic farming standards without chemosynthetic pesticide used) and two contrasting fertility managements (mineral fertiliser-based protocols used in conventional farming or composted manure inputs according to the organic farming standards). Each year the harvested crops were supplemented with protein, fat and minerals, and processed into four experimental rat diets containing plants cultivated according to: the organic, the conventional and two low-input standards. Reference group consisted of the rats fed with standard laboratory feed for rodents (Labofeed H). The experimental feeding of the first generation lasted 12 weeks in the 1st and 3rd year while in the 2nd year it was extended to two consecutive generations. In the 3rd year half of the animals was submitted to the experimental peritonitis and the effect was evaluated 4 hours after inflammation was elicited. Each year the feed composition and consumption, rat growth and physiological parameters (body composition and plasma hormones) were evaluated. In the present study the main focus was on the blood and immune system measures, while the result of other assessments were taken into account for the results discussion and interpretation. In the first two years of the experiment, the rat erythrocyte number, packed cell volume, haemoglobin level, white blood cell number, immunoglobulin level, plasma C-reactive protein level and splenocyte proliferation were assessed. In the 3rd year the assessments of blood haemoglobin level and the inflammation indicators were carried out. The number and percentage of blood leukocytes, percentage and activity of peritoneal leukocytes, splenocyte
proliferation, plasma C-reactive protein level, plasma and peritoneal interleukin 1β, 6 and 10 level were measured.

Comparison of the results obtained from the dietary groups showed that:

- Rats fed with feeds from organically grown crops, rich in the antioxidants (polyphenols, flavonols and lutein), had the highest blood number of erythrocytes, leukocytes, and haemoglobin level, as well as the highest plasma level of immunoglobulin A and M, and splenocyte proliferation. During the inflammation process they exhibited also the lowest percentage of granulocytes and monocytes in the blood, as well as the lowest number of peritoneal leukocytes and level of interleukin 1β and 6 in both the blood and peritoneal fluid.
- Animals on the diet produced from mineral fertilised plants, which had more nitrates, had lower erythrocyte number, plasma immunoglobulin G level and splenocyte proliferation. This diet, containing also a higher content of heavy metals (cadmium and lead), resulted in higher plasma C-reactive protein level, and also higher number of leukocytes in blood and peritoneal fluid, splenocyte proliferation, activity of peritoneal leukocytes, C-reactive protein and interleukins (1β and 6) during the inflammation process.
- Rats fed with organically fertilised crops rich in mycotoxin nivalenol, had lower level of plasma immunoglobulin A and G while higher that of C-reactive protein
- Animals fed with feeds from crops grown under conventional protection, with higher content of the pesticide residues and growth promotors, during the inflammation process exhibited lower B-cell proliferation, plasma C-reactive protein and interleukin 10 levels simultaneous with the higher peritoneal interleukin 1β and 6 level, and leukocyte activity.
- Moreover, rats on the diet from crops grown under pesticide-based protection, had higher splenocyte proliferation resulted possibly from the elevated plasma content of growth hormone and insulin-like growth factor.
- Animals fed with mineral fertilised crops had lower erythrocyte number, plasma immunoglobulin M and C-reactive protein levels, and splenocyte proliferation, related most probably with the increased plasma testosterone concentration.
- The protein quality of cereals (wheat or barley) used to produce feeds had the opposite effects on the plasma level of immunoglobulin A and G in rats from the consecutive experimental years.

It can be concluded that the agriculture practices used to grown crops from which experimental feeds were made, especially fertilisation management, had an effect on basic physiological parameters and immune system function during homeostasis and inflammation process as well. Better immune system function may be an effect of the antioxidants present in the organic crops. A lower immune system potential was probably an effect of the nitrate and heavy metal contamination of conventionally fertilised crops and/or mycotoxins in organically protected plants. While there was no effect on haematological and immune system parameters in homeostasis, feeds high in pesticide residues caused the strongest inflammatory response, which can be considered as the elevated risk of chronic diseases. The experimental feeds can affect the immune system function directly or thoughtout the neuroendocrine regulation. The study presented here is a good starting point for further investigation of the inflammation dynamics in the animals fed with feeds from crops grown in the contrasting agricultural systems.