POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

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Pol. J. Food Nutr. Sci.
2009, Vol. 59, No. 1, pp. 11-15

ANALYSIS OF LABORATORY ANIMAL HEALTH STATUS AND FERTILITY IN BIOLOGICAL EVALUATION OF ORGANICALLY-PRODUCED CROPS – A REVIEW

Ewa Rembiałkowska, Katarzyna Wiśniewska

Chair of Organic Foodstuffs, Faculty of Human Nutrition and Consumer Sciences, Warsaw University of Life Sciences, Warsaw, Poland

Key words: organic crop, plant product, laboratory animals, health status parameters

The analysis of the influence of products with organic and conventional crop on health status parameters of laboratory animals was the aim of studies provided by several authors over the last fifty years, who compared: development rate, fertility and reproductive ability of rats, mice, rabbits and hens. In nine out of thirteen analysed studies, organic fodder has been demonstrated to exert a positive influence on parameters of the health status of laboratory animals. All of the studies concerning mortality rate of the young animals indicated the lower stillborn level in animals fed with organic fodder in comparison to those fed conventionally. Therefore it is possible to support a hypothesis that fodder obtained from organic produce may have a beneficial effect on animal health status, especially in relation to reproduction performance, pregnancy and immune system.

It has to be emphasized that already conducted studies are not sufficient to fully confirm hypothesis described above and further and thorough studies are needed in this scope. The analysis of previous research and its results is essential to determine the scope and fields that need further investigation.

INTRODUCTION

Organic agriculture is defined by Council Regulation (EEC) No. 2092/91 of June 1991 on organic production of agricultural products and indicates referring thereto on agricultural products and foodstuffs. Organic plant products are produced without synthetic fertilizers and pesticides. An animal and green manure, compost and proper crop rotation are widely used in that type of agriculture. It is forbidden to use municipal compost and waste in organic farms. Organic animal husbandry proceeds in accordance with needs and behaviour of a species. Fodders for breeding animals are produced on the farm. Certification in organic farming means that certification body confirms that organic foodstuffs were produced according to the accepted rules and that the production system is subject to obligatory control. The main principle of organic agriculture and processing is rejection of agricultural, veterinary and food chemical substances and GMO during the production process [Rosati & Aumaitre, 2004]. There is still not enough scientific studies concerning health effects of long-term intake of organic food in human and animals in spite of rising consumer interest in organic food [Lund & Algers, 2003].

The aim of this paper is to analyse the literature concerning the impact of long-term feeding of laboratory animals with fodder from organic and conventional cultivation. There are number of scientific evidences supporting the theory that yields from organic production may have potentially a more beneficial influence on mammal's health than the conventional crops. This is due to the fact that organic crops contain significantly less contaminations of the proven negative impact on health (nitrates, nitrites, pesticide residues, growth regulators). At the same time many studies have shown that produce from organic system contain as a rule more dry matter, vitamin C and B-group vitamins, as well as more polyphenolic compounds, indispensable amino acids and total sugars. They also contain statistically more iron, magnesium and phosphorus. The above-mentioned substances, particularly vitamin C and polyphenols are considered to be important antioxidants preventing morbidity of several diseases, including carcinogenesis.

Lifestyle and environmental factors and above all the increase of the chemical contaminations in environment, are considered as one of the main causes of fertility decrease among people and animals [Sharpe *et al*., 2002]. A lot of reports have been published on decreasing quality and amount of sperm in men in many European countries [Auger *et al.*, 1995; Carlsen *et al.*, 1992]. Moreover toxicologists notice also more frequent occurrence of cancer and various types of abnormalities, including limitations of mental development, hypospadias in men and premature puberty in girls [Groten *et al.,* 2000; Howard *et al.,* 2005]. Chemization of environment, with special regard to pesticides used in agriculture, is considered to be one of the main causes [Groten *et al*., 2000; Howard *et al.,* 2005]. Acute poisonings are usually a result of the improper use of almost all pesticides. Carcinogenesis, neurotoxicity, fertility disorder, as well as disorders in devel-

Author's address for correspondence: prof. dr hab. Ewa Rembiałkowska, Chair of Organic Foodstuffs, Faculty of Human Nutrition and Consumer Sciences, Warsaw University of Life Sciences, ul. Nowoursynowska 159c, 02-776 Warsaw, Poland: e-mail: ewa_rembialkowska@sggw.pl

TABLE 1. Studies comparing selected health status indicators of animals fed on organic and conventional fodder.

Studied animals	Studied indicators	Obtained results [**O group** – fed on fodder from organic cultivation]	Author
Mice	– the ability of females to get pregnant	– significantly higher number of pregnant females and less degenerative changes in ovaries in group **O**	Scott *et al*. [1960]
Mice	– the ability of females to get pregnant	– no differences were observed between two groups of mice	McSheehy [1977]
Rabbits	– the condition of female reproductive organs, fertility	– positive changes at reproductive organs: greater weight of ovaries, more ova, more frequent ovulations in group **O**	Aehnelt & Hahn [1973; 1978]
Rabbits	– mortality of young animals	– lower mortality of the young in group **O** (27% vs. 51%)	Gottschewski [1975]
Rabbits	– the condition of female reproductive organs, fertility	– no significant differences in two groups	Meinecke [1982]
Rabbits	– body weight gain – the conditions of the newborns	– greater body weight gain in group **O** – higher percent of young born alive in group **O**	Edelmuller [1984]
Rabbits	– fertility in 3 generations	– higher fertility of rabbits, more embryos at rabbits in group **O**	Staiger [1986]
Chickens	– weight gain – morbidity – egg's weight	– greater weight gain in group **O** – lower morbidity in group **O** – higher weight of eggs in group **O**	Plochberger [1989]
Rats	– the birth weight of the young – survival rate of the young – weight gain of the young – changes in mother's weight during lactation	– higher percent of young born alive in group **O** – superior body weight gain of females during and after lactation in group **O** – no influence of fodder on the female's ability to get pregnant	Velimirov *et al*. [1992]
Rats	– body weight gain – consumption rate – total serum proteins – stimulated proliferation of lymphocytes *in vitro* at rats fed *ad libitum* and on diet with protein shortage – analysis of the proteins of the acute-phase reaction of liver on the inflammation	– no differences – no differences – no differences – stimulated proliferation of lymphocytes similar at rats fed *ad libitum* in organic and conventional group – stimulated proliferation of lymphocytes higher in group **O** on diet with protein shortage (according to authors the evidence that immune system of **o** rats worked better, therefore conventional fodder presumably contained more total toxins, even if **o** fodder had higher levels of DON mycotoxins) – no differences in acute-phase reaction proteins between groups	Finamore *et al*. [2004]
Rats	– body weight gain – epididymis weight – testicle histopathology – sperm density	– no differences in body weight gain and epididymis weight – no differences in number of degenerative changes – no differences in sperm density	Jensen [2004]
Rats	– utilization of nutritional components – physical activity – „post mortem" evaluation of organs – biomarkers analysis in blood and tissues – analysis of the immune response.	– lower body fat content in group **O** – more distinct division on day and night activity in group **O** – higher level of α-tocoferol in blood of rats in group **O** – higher level of Ig G in blood serum of rats in group **O**.	Lauridsen *et al*. [2005]
Rats	– blood haematology – spontaneous splenocytes proliferation – stimulated lymphocyte proliferation	– spontaneous splenocytes proliferation higher in male group **O** but lower in female group **O** – stimulated lymphocyte proliferation (by mitogen T cells) higher in group fed conventionally (the tendency not statistically significant)	Barańska *et al*. [2007]

opment and functioning of the immune system are chronic health effects connected with pesticide residues. The risk of the above-mentioned health disorders is significantly higher in children than in adults. When conducting standard experiments on toxicity of a single pesticide introduced on the market, there is no possibility to predict the effect of mixing different xenobiotics present in conventional food on human health, especially after long-term consumption in several generations. An increase of morbidity and various malformations are the price that developed countries have to pay for uncontrolled technological progress and agricultural chemization.

FEEDING EVALUATION OF ORGANICALLY-PRODUCED CROPS

Most of feeding experiments conducted currently on laboratory animals concentrate on investigating negative and/or positive results of a single nutritional component and single toxin or their metabolites. On the other hand, studies into the influence of complete fodder based on organic or conventional produce have different character. It is not about the influence of the single component on animal body, but about the influence of several factors which are connected with the farming system, but are only partly recognised by science.

The effect of the range of compounds is investigated, which combines various reactions. For this reason, the interpretation of these studies is more difficult and scientists who are used to study specific compounds may perceive it as less precise from the scientific point of view. However, systemic approach has to be acknowledged as proper in the case of comparing the influence of two extremely different production methods of agricultural produce on animal body.

It should be emphasised that appropriate choice of conventional fodder is extremely important in this kind of research. Produce for the production of conventional and organic fodder should originate from experimental plots with a strictly defined cultivation system. All experimental plots should have similar climatic and soil conditions. Only properly planned experiment enable to draw correct conclusions from comparative studies.

During the last fifty years a dozen of feeding studies have been conducted, among which most indicated a positive influence of organic fodder on selected parameters of health status and fertility of the laboratory animals [McSheehy, 1977; Aehnelt & Hahn, 1978; Gottschewski, 1975; Edelmuller, 1984; Staiger, 1986; Plochberger, 1989]. Researchers that carried out those studies were the pioneers who determined experiments with laboratory animals as a method of investigating the impact of the farming system on nutritional value of the obtained products (Table 1).

EFFECT OF FODDER ON FERTILITY PARAMETERS OF LABORATORY ANIMALS

Fertility of animals which is less connected with genetic inheritance than other parameters is frequently treated as an adverse environment condition indicator.

Studies conducted on laboratory animals have proven the negative influence of a few pesticides used in conventional farming on the fertility rates. Examples of the above-mentioned studies are experiments estimating a toxic effect of cypermethrin pesticide on the fertility parameters in rats [Elbetieha *et al.,* 2001] and a genotoxic effect of pyrethroid on mice [Bhunya *et al.,* 1988]. These results were obtained with a significantly higher amount of chemical agents than permissible concentrations of single pesticide residues in fruits and vegetables. However, very little is known about the consequences of body exposure to long-term, simultaneous contact with various pesticide residues [Reffstrup, 2002; Carpy *et al.*, 2000]. It cannot be excluded that pesticides even in small, officially permitted doses disturb the hormonal balance of a body, which has a great impact on its proper development and functions, including fertility [Howard, 2005]. In the case of organic food the pesticide residues are practically absent. At the same time, according to many studies by several authors, it was observed that crops from organic production contained usually more health beneficial compounds [Rembiałkowska, 2004, 2007; Shane, 2001; Worthington, 2001; Williams, 2002]. An experiment comparing a sperm density among farmers from organic and conventional farms indicated higher sperm density in organic farmers [Abell *et al.*, 1994]. For this reason, the hypothesis was formulated that health status and fertility of animals, as well as humans may be improved by applying a diet consisting of products originating from organic farms.

The ability of female mice to become pregnant was an object of research by Scott *et al.* [1960] and McSheehy [1977], however the results were not coherent. Studies were conducted only on one generation and there was no chemical analysis of fodders given to animals. Differences between results might have been caused by a different level of pesticide residues as well as by other chemical substances which were not analysed.

The influence of fodder from different agricultural systems on the fertility of rabbits was investigated in four experiments. Two of them confirm a positive effect of fodder from organic cultivation on the studied parameters [Aehnelt *et al*., 1973; Staiger, 1986]. Two others show no differences in the fertility of females and the state of their generative organs [Alter, 1978; Meinecke, 1982]. The quality of studies, including the number of generations in the experiment is more important rather than their quantity. Only studies conducted by Staiger [1986] included three generations of rabbits, showing that the fertility of laboratory rabbits fed on organic fodder was at the same level among all generations and was decreasing gradually in the group fed on conventional fodder. A drawback of Staigers' experiment was an additional, unexpected factor that appeared in the second generation – noise caused by renovation works. A noise caused cannibalism in 27% of females and trampling of the young. The only research concerning fertility of rats is a Danish experiment [Jensen, 2004]. In the above-mentioned study no statistically significant differences were found between groups fed on organic and conventional fodder in relation to: epididymis weight, number of degenerative changes in testicles and sperm density. However Jensen's paper [2004] does not include qualitative analysis of rat sperm, which may be of great significance in determining fertility of the studied rats as the number of non-deformed spermatozoa is the main factor determining the ability to insemination.

ORGANIC AND CONVENTIONAL FODDER *VS.* SELECTED PARAMETERS OF THE IMMUNE SYSTEM FUNCTIONING

First studies regarding the impact of fodder on selected immunological parameters in rats were conducted by Finamore *et al.* [2004]. The aim of this study was to estimate the potential risk connected with organic food consumption; as organic wheat dosed to those rats contained on average more DON mycotoxin than conventional wheat. However, results of investigations comparing mycotoxin content in cereals from organic and conventional production are discrepant. In the experiments by Czerwiecki *et al.* [2002a, b] in the first year significantly higher levels of ochratoxin A were found in cereals from organic farms, whereas in the second year there was more ochratoxin A in cereals from conventional farms. The authors concluded that the level of ochratoxin A was influenced equally by methods of production and storage conditions.

In the above-mentioned experiment by Finamore *et al.* [2004], selected groups of rats were particularly sensitive,

since diet with reduced protein content was additionally applied. While studding the response of lymphocytes, it was found that stimulated proliferation did not differ significantly between groups fed on organic and conventional fodder, when rats were given feed *ad libitum*. However when rats were fed on a diet with protein shortage, the stimulated proliferation of lymphocytes was higher in a group fed on organic fodder. In the author's opinion [Finamore *et al*., 2004], the results obtained may indicate a better response of the immune system in the case of exposure to toxin in rats fed on organic fodder. The authors speculate that it indicates a lack of different toxins, except for DON mycotoxins, in organic wheat given to rats.

Danish studies on the functioning of the immune system showed a higher level of Ig G in blood serum in rats fed on organic fodder [Lauridsen *et al.*, 2005]. It demonstrates a higher immune system reactivity after contact with antigen as the secondary immune response. A pilot experiment [Barańska *et al.*, 2007] concerning the functioning of the immune system showed higher splenocytes proliferation in male rats fed on organic fodder. Since it was only a pilot research, such studies should be continued. On the basis of all the above-described studies, it is possible to state that products from organic and conventional farming exert a different influence on the immune system functioning and that those differences are significant. There is a need for further research in that field to find out the reasons and consequences of the observed diversity.

CONCLUSIONS

Studies presented above on the influence of fodder consumption based on organic and conventional produce on the health status of laboratory animals are sparse, moreover there is a lack of systematic and long-term investigations in this scope. Therefore only preliminary conclusions can be formulated:

1. There is a noticeable tendency of more beneficial parameters of fertility and survival rate of the young animals fed on fodder based on organic produce in comparison to animals fed conventional fodder.

2. A tendency can also be observed of more favorable parameters of the immune system functioning in rats fed on fodder based on organic produce as compared to rodents on conventional fodder.

3. A different function of the immune system is observed in rats fed on fodder based on organic produce in comparison to rats fed on conventional fodder.

Further, well-planned experiments are necessary in order to evaluate fertility, immune system and condition of laboratory animals fed on fodders from different farming production systems. Those studies should include several generations and be connected with the multilateral analysis of the chemical composition of dosed fodders.

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Received January 2008. Revision received April and accepted November 2008.