

USE OF A RAT MODEL TO ELUDICATE IMPACT OF ORGANIC FOOD ON HEALTH

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Abstract – Ingredients (potatoes, carrots, peas, green kale, apples, and rapeseed oil) were grown according to three different cultivation systems (“Organic”, low input of fertilizer without pesticides; “Minimally fertilised”, low input of fertilizer and high input of pesticides, “Conventional”, high input of fertilizer and high input of pesticides). Three iso-energetic and iso-nitrogenous diets were composed of equal proportions of the ingredients originating from each of the cultivation systems, and the diets were investigated with respect to several physiological responses and biomarkers of health using a rat model. In addition, the diets were tested in a food preference test using the same type of rats, but another generation. In both experiments, the diets were optimized according to the nutritional requirements of reproducing rats, except for a high content of fat. Most of the measured variables (biomarkers of health) showed no differences between the experimental diets, however, some differences between dietary treatments were obtained, which were in favour of the “organic” diet contrasted with the “conventional” diet. The preference test showed a significant interaction between diet choice and mother’s diet. However, the results obtained from the present study cannot be extrapolated to all organic and conventional cropping systems, mainly because crops were grown only in one replication. Thus, it is of outmost importance that future investigations on the effect of organic food in relation to human health and well-being should be based on well-defined and controlled food produce system with replications.¹

INTRODUCTION

Quality and safety of food are important issues, which receive ever-increasing attention in the general public. The consumption of organic foods has been steadily increasing during the last decade, particularly in Western countries (Meier-Ploeger 2005). Many consumers perceive that organic foods are of better quality, healthier and more nutritious than food produced using conventional methods. However, research on possible impacts on animal and human health is sparse (Williams 2002). Moreover, the majority of studies reported in the literature are outdated because the practices in both organic and conventional agriculture have changed over time. According to a Danish knowledge-synthesis reviewing the scientific literature (O’Doherty Jensen et al. 2001), there is no evidence, which in an incontestable way support or refute such perceptions.

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A large number of studies have addressed the question “whether organic food is more beneficial for health than conventional one”, and most of these studies have measured the content of well-known vitamins or minerals in plant foods of more or less controlled origin and conclude that there are relatively small but often significant differences. However, it is not yet possible to extrapolate from compositional differences in the food to possible effects on health. Actually, the question is very difficult to address, according to the following key-points: 1) the term “health” has a very broad definition, 2) the “human menu” consists typically of many food items produced in several cultivation/production systems, and 3) humans are so genetically and environmental different that eventual differences between cultivation systems may be difficult to detect due to variability.

The subject has also been studied in some recent publications: Finamore et al. (2004) concluded that conventional wheat represented a higher risk for lymphocyte function than those grown organic. In addition, the growing conditions of fruits and vegetables (conventional vs. organic) affected the content of five selected flavonoids and resulted in differences in the urinary excretion of major dietary flavonoids that are markers of oxidation in humans (Grinder-Pedersen et al. 2003).

In the present study we addressed the question by conducting a well-controlled rat-feeding experiment comparing three iso-energetic and iso-nitrogenous diets composed of vegetables and a high content of rapeseed oil (13 %), produced according to each of three different cultivation systems. The purpose of the study was to investigate whether a difference in growing conditions of the feed plants would affect any of a range of physiological responses indicative of “health” using a rat model, being characterized as non-insulin dependent diabetes mellitus, type II diabetes and non-obese.

METHODOLOGY

The experiment was performed with 36 rats that were fed on three diets consisting of potatoes, carrots, peas, green kale, apples, and rapeseed oil. The difference between the three diets was the three combinations of cultivation strategies used to grow the used ingredients:

- “Organic”: low input of fertiliser through animal manure and without pesticides
- “Minimally fertilised”: low input of fertiliser primarily through animal manure and with pesticides
- “Conventional”: high input of mineral fertiliser and with pesticides

Each ingredient type was cultivated according to standard practice for the crop in terms of e.g. levels fertilizer and timing of pesticide applications. For each crop all treatments were carried out on the same or adjacent experimental fields, which were divided according to the three cultivation strategies, so that the cultivation took place in similar soils and under similar climatic conditions, and the ingredients were harvested and treated at the same time.

The three experimental diets had exactly the same formulation (300.0 g kg⁻¹ potato, 50.0 g kg⁻¹ carrot, 472.4 g kg⁻¹ pea, 10.0 g kg⁻¹ green kale, 10.0 g kg⁻¹ apple, 130.0 g kg⁻¹ rapeseed oil, 6.4 g kg⁻¹ DL-methionine, 12.5 g kg⁻¹ CaCO₃, 0.7 g kg⁻¹ salt, and 8.0 g kg⁻¹ vitamin/mineral mixture), and the diets (mean ± SD) were iso-energetic (dry matter (DM) 966.7 ± 5.0 g kg⁻¹, gross energy 21.2 ± 0.14 MJ kg⁻¹ DM, metabolisable energy 18.0 ± 0.14 MJ kg⁻¹ DM) and iso-nitrogenous (crude protein 160.7 ± 0.2 g kg⁻¹), and contained in addition the following main nutrients: HCl-fat 156.5 ± 1.6 g kg⁻¹, ash 41.4 ± 0.5 g kg⁻¹, crude fiber 56.3 ± 1.6 g kg⁻¹, dietary fiber 179.3 ± 2.1 g kg⁻¹, calcium 6.8 ± 0.1 g kg⁻¹, total phosphorus 3.4 ± 0.1 g kg⁻¹, lysine 10.8 ± 0.2 g kg⁻¹, and methionine + cystine 9.7 ± 0.4 g kg⁻¹. The pesticide level was determined by the Regional Veterinary and Food Control Authority Copenhagen, Danish Veterinary and Food Administration, and was found to be below the detection limit.

The rats received the same diets throughout their entire life and the measurements of their health status started after weaning of their first litter (age, 19 weeks; weight, 212 g). The following measurements were used to assess rats' health status:

- Clinical health and disease
- Bioavailability of nutrients and metabolism
- Physical activity
- Functions of organs and intestine
- Post mortem evaluation of organs
- Analyses of biomarkers and nutritional status in blood and tissues
- Analyses of immune response

In another experiment using the same dietary treatments, we performed a food preference test in which rats were given access to all three diets during a period of 5 days. Rats were weaned from mother rats, which throughout their entire life were fed one of the three diets.

RESULTS AND DISCUSSION

The rats thrived on all three diets, and showed only minor differences with respect to utilisation of energy and nutrients. Even though the rats were genetically disposed for diabetes, there was no visual sign of this disease among the rats. The rats had only a slight increase in weight after eating the diets for 25 weeks. Most of the measured variables (biomarkers of health) showed no differences between the experimental diets, however, some differences between dietary treatments were obtained, which were in favour of the "organic" diet contrasted with the "conventional" diet (Lauridsen et al., 2005).

The preference test showed a significant interaction between diet choice and mothers' diet: when

mother's diet was "organic", the "organic" was among the preferred diets. However, when the mothers were fed "minimally fertilised" or "conventional", the rats showed the lowest consumption of "organic". The results are presented in detail elsewhere (Yong et al., 2005). Overall, the trial showed that rats had individual preference among the diets of the three different cultivation systems irrespective the similar content of nitrogen and energy, and that the diet choice of the progeny was conditional in the maternal dietary treatment. Therefore no definitive conclusion could be drawn with regard to the selection of food from one cultivation system in preference to food of another.

The trials show that the rat is a sensitive animal model applicable when testing even minor nutritional differences. In a future trial, the mechanisms involved in the obtained differences among the dietary treatments will be elucidated, and the field trial will be designed so that conclusions regarding cultivation systems can be extrapolated. It is then expected that the rat model will provide the human nutrition research area with important tools that can explain eventual interactions between food of different cultivations systems and effects on biomarkers of health.

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