

IMPACT OF ANIMAL HEALTH MANAGEMENT ON ORGANIC PIG FARMING IN GREECE

V.G. Papatsiros

Clinic of Medicine, Faculty of Veterinary Science, University of Thessaly, Karditsa, Greece
Corresponding author: Dr. Vassilios G. Papatsiros, e-mail: vpapatsiros@yahoo.com
Communication

Abstract: In Greece, organic pig farming started in 2002 and since then made significant steps forward due to the extended interesting of Greek consumer for organic products during last decade. This report aims at updating information about organic pig farming in Greece, relating production system and most health risk factors. Furthermore, in present study a animal health management program is proposed.

The most common health problems that occur in the Greek organic pig farming are respiratory problems, gastrointestinal problems, claw and skin problems, parasitic infections and piglet mortality. A veterinary health management program in organic pi farms, including use of alternatives to antibiotics (prebiotics, probiotics and phyto-genics), antiparasitics, appropriate vaccinations (e.g. against *E. coli*, *M. hyo*, PRRSV) and the appropriate disinfection program (e.g. rodent management with rodenticides) could be an useful tool for prevention and control diseases as well as for improvement of growth performance.

In conclusion, the productivity growth in Greek organic pig farms can be increased by improving the living conditions of animals and the implementation of preventive measures (e.g. vaccination programs, treatments with phototherapeutics) that reduce mortality rates (especially during the winter months). For this reason the application of a herd health management program is necessary in organic pig farms.

Key words: organic farming, pig, risk factors, Greece

Introduction

Greece has a comparative advantage over other countries in terms of organic farming, due to favorable pedo-climatic conditions, rich natural resources in mountainous and semi-mountainous areas, the rich biodiversity of plant life (with a significant number of endemic plants in the different geographical districts) and extensive farming, which can easily be converted to organic. Organic animal

farming is directly related to organic agriculture farming because the nutritional needs of animals other than grazing and covered with organic feed.

The importance of organic pork in Europe has been rising during the last years. The National Greek projects of organic pig farming started in 2002. Most of EU countries had an increasing number of organically produced pigs and Greece had one of the most enormous increases in Europe (*Lampkin et al., 2007*). That is why in the beginning of 2005 Greece has become the second largest organic pig producer in the EU with over 100,000 pigs (Table 1). With the exception of Greece (13% national production share in 2005) the market share of organic pig production in Europe amount to less than 2% (*Llorens Abando and Rohner-Thilen, 2007*). The contribution of organic pig farming in total Greek organic livestock farming was minimal until in 2004, but then, has grown significantly, reaching a participation rate to 15% (*DOA, 2009*). In 2002, the total number of organic pigs was just 1.288. Since then and until 2005 a steady increase was observed while, in 2006-2007 a significant increase was noticed, reaching the number of 175.000 organic pigs (*DOA, 2009*).

Table 1. Number of organic pigs from 2002 to 2007 in Greece.

YEAR	2002	2003	2004	2005	2006	2007
	Total number of organic pigs					
Total number of pigs	1,288	3,628	4,469	126,003	110,096	175,004
Fattening pigs	1,238	1,648	1,856	**	87,669	69,180
Sows	18	752	2,557	**	20,345	18,200
Other pigs *	32	1,228	56	**	2,082	87,624

(*) Including estimated young animals, (**) there is not published data

Source: Directorate of Organic Agriculture, Ministry of Rural Development and Food, www.minagric.gr.

The National Greek projects of organic pig farming started in 2002. The contribution of organic pig farming in total Greek organic livestock farming was minimal until in 2004, but then, has grown significantly, reaching a participation rate to 15%. In 2002, the total number of organic pigs was just 1.288. Since then and until 2005 a steady increase was observed while, in 2006-2007 a significant increase was noticed, reaching the number of 175.000 organic pigs (*DOA, 2009*).

Most Greek consumers do not seem to be aware of the meaning of balanced nutrition, but food borne hazards is the greatest worry (*Zervas, 2007*).

Their concern for consuming safe food seems to affect their preferences for specific types of market, according to value and trust criteria. This selection is also affected by personal criteria, according to which many consumers seem to assess possible causes of food borne hazards and ways to avoid them as well. Disease prevention is a key point in organic livestock production. Health management by identifying and controlling the level of risk factors may therefore be particularly relevant for organic farmers (*Arsenos et al., 2004*).

The aim of this study is to provide information about organic pig farming in Greece, relating production system, genetic background, diets and most health risk factors. Furthermore, in present study a herd health management program is proposed.

Genetic, diets, health problems. Swine breeds that are usually preferred in the Greek organic pig farming are types of Greek domestic swine and various domestic pigs derived from crossbreeding between male Greek domestic pigs and improved breeds, such as Large White and Landrace.

According to the legislation in force about organic pig farming, all animals should originate from organic farms, except the cases that are required to renew the herd, so it is allowed to entrance conventional pigs in a percentage of 20% or in a percentage of 40% in cases of increasing the capacity or of s changing of breeding stock. Therefore, the different Greek domestic swine breeds (which still exist up today in many mountainous areas) can be the initial breeding stock (sows and boars) of organic pig farms, that after a short period of just 4 months, could be a grandparent nucleus of sows which will be kept in the farm for producing its own organic gilts. In organic pig farming, organic feed have to be used, preferably from the same unit or another organic unit. However, it can be used to 30% transition feed, except where the feed from the same farm where the percentage is until 100%. Therefore, the function pig units, which produce their organic feed, could contribute significantly to securing the required quantities of feed and at the same time reducing production costs.

The most common health problems that occur in the Greek organic pig farming are respiratory problems, gastrointestinal problems, claw and skin problems, parasitic infections and piglet mortality. The housing condition of organic farming may predispose animals to various infectious micro-organisms, normally no longer present indoors because of the strict hygienic measures that are taken.

Causes of high piglet mortality are skin traumas or crushing of piglets by the sow and diarrhea syndromes in suckling and weaning piglets. Other health problems in weaned pigs are respiratory diseases, arthritis and endoparasites. The risk factors suggested for diarrhea in weaned pigs are related to feed quality and hygiene of outdoor area, indoor pens and wallowing holes. In Europe, studies reported that neonatal diarrhea is uncommon in organic pig production, possibly

due to routine vaccination with *Clostridium peifringens* and *enteritis* (Feenstra, 2000), but diarrhea is noticed in finishing pigs (Baumgartner et al., 2003). Therefore the improvement of animal welfare and housing conditions, e.g. the construction of simple and well designed facilities, including batches with infrared lamp for piglets, can significantly reduce piglets' mortality (especially during the winter months). Common are also respiratory problems, with usually sign the pneumonia, mainly in growing and finishing pigs. Causes of pneumonia usually involve pathogens such as *Mycoplasma Hyopneumoniae*, *Actinobacillus pleuropneumoniae* and Porcine Reproductive and Respiratory Syndrome Virus (PRRSV). Studies in Austria showed similar finding (Baumgartner et al., 2003).

Furthermore, in sows most common problems are leg problems (lameness, hoof injuries and abscesses), reproductive disorders (variations in litter size and abortions or returns-to-oestrus) and poor body condition. Apart from that, poor body condition and reproduction problems are frequently observed in the sows, and stone chewing in pregnant sows. Important risk factors for leg problems in sows are considered to be genetic factors affecting leg strength, diseases in legs and hooves, ground condition in outdoor areas and management in the mating area (increased social activity resulting in trauma). Poor mating management regarding oestrus and pregnancy testing, synchronization of oestrus in sow batches and poor body condition are regarded as important risk factors for reproductive problems in the herd. Similar findings are referred from other studies in organic pig farms in Europe (Feenstra, 2000; Vaarst et al., 2000; Kampshof and Steverink, 2001).

Another common situation formulate identified are the various ectoparasites and endoparasites because of non-parasitic programs prophylaxis regimens. More frequently parasites in Greek organic pig farms are *Sarcoptes scabiei*, *Trichuris suis* and *Ascaris suum*. Especially *Ascaris suum* causes growth retardation and 'milk spot' lesions in the liver. Pigs need some place for rooting which is one of the basic needs of them. Rooting helps against tail biting but paddocks are a very suitable environment for *Ascaris suum*, *Trichuris suis* and maybe also for other helminths. Endoparasites and ectoparasites must be considered one of the major constrains for welfare and health as well as economy in organic swine production, especially during post weaning period (Mejer et al., 1999; Nansen and Roepstorff, 1999; Leeb and Baumgartner, 2000; Vermeer et al., 2000). In Europe, studies have shown high prevalences of helminth infestations in organic outdoor pig production (Roepstorff et al., 1992; Carstensen et al., 2002).

An important risk factor in organic pig production is the more frequent, compared with conventional swine industry, in contact with rodents. Rodents are actors - tank of several pathogens, some of which are hazardous to public health, such as *Trichinella* spp., *Toxoplasma gondii*, *Salmonella* spp., *Campylobacter* and *Leprosira* spp. *Salmonella* and *Campylobacter* spp. are the most important causes of bacterial gastroenteritis in humans and are responsible for food-borne diseases

(Mead *et al.*, 1999; Tauxe, 2002). Wild rodents may spread zoonotic bacteria between farms (Gratz *et al.*, 1994; Hiatt *et al.*, 2004; Leirs *et al.*, 2004). A comparison of the *Salmonella*-seroprevalence in Danish organic, free-range, conventional and breeding pig herds (Wingstrand *et al.*, 1999) showed that the risk of meat juice samples being seropositive was higher for organic and free-range than for conventional herds. This risk may be even greater in organic production, where contact with livestock is more likely and rodenticides are used less often. Organic farmers should apply effective rodent management that is in line with organic principles to protect livestock and human health (Meerburg *et al.*, 2004).

Animal health management. In order to prevent the above diseases, it is suggested the replacement animals in organic farms to derived from breeding organic or conventional farms, which are 'free' from parasitic and respiratory diseases. Furthermore, it is important especially for the conventional farms to apply the necessary preventive antiparasitic and vaccination programs.

Disease prevalence and veterinary treatments in organic animal production differ from conventional systems. According to the European Commission (EC) regulation on organic agricultural production (EC, 2004), disease prevention is based on the principles that the feeding, housing and care of the animals should limit animal health problems so that they can be controlled mainly by prevention. If, despite these preventive measurements, treatment should be necessary, phytotherapeutic and homeopathic products should be used in preference to chemically synthesized allopathic veterinary medicinal products, provided they are therapeutically effective. Most important current EC organic regulations for the animal treatment are:

A) First of all there is a treatment requirement. Sick animals must "immediately" get treated. Thus, a farmer acts adversely to the regulation, if he does not give treatment to his ill livestock.

B) The organic farming favours complementary medicine, because these are to support the defense mechanism of the organism, without leaving chemical residues in dung and food. Homeopathic and phytotherapeutic products are to be preferred provided that they actually have a therapeutic effect on the animal species and the illness. But: "*chemically-synthesized allopathic veterinary medicinal products or antibiotics may be used under the responsibility of a veterinarian*" if the alternative treatment "*is unlikely to be effective*".

C) The doubling of the legal withdrawal period for chemical drugs in the organic farming is to improve the desired consumer protection: "*The withdrawal period... is to be twice the legal withdrawal period or, in a case in which this period is not specified, 48 hours.*" The duplication of the withdrawal period and the 48-hours rule only concerns the *allopathic veterinary* remedies, thus everything that is not ranked among the *homoeopathics*. This would concern also the

phytotherapeutics. The 48-hours rule concerns as well medicinal products with a legal withdrawal period of 0 days.

D) Finally, the number of “*chemically-synthesised allopathic veterinary*” treatment courses is restricted. This means: Two treatment courses in fattening pigs and fowl inhibit the marketing as an organic product.

In recent decades, prebiotics, probiotics and phytoGENICS (also referred to as botanicals or phytobiotics) have been used as potential alternatives to antibiotics in swine diets (Mroz, 2005; Windisch et al., 2008; Jacela et al., 2010). The proposed benefits from probiotics are improved digestion, stimulation of gastrointestinal immunity, and increased resistance to infectious diseases of the gut (Doyle, 2001; Zimmermann et al., 2001). For example, probiotics containing *Bacillus cereus var Toyoi*, *Bacillus licheniformis* or *Bacillus subtilis* spores have in sows and their litters had positive effect on health status and performance characteristics of sows as well as of weaning, growing and finishing pigs, as well as on the reduction of incidence and severity of Post Weaning Diarrhoea Syndrome (PWDS), (caused mainly by enterotoxigenic *E. coli* - ETEC strains) (Alexopoulos et al., 2001, 2004a,b; Kyriakis et al., 1999, 2003). PhytoGENICS have significant antimicrobial activity against bacteria (especially Gram negative bacterial species, like *Salmonella* spp. and *E. coli*) yeasts, moulds (Tsiloyiannis et al., 2001a,b; Øverland et al., 2007; Creus et al., 2007; Piva and Grilli, 2007; Papatsiros et al., 2009) and parasites (like *Ascaris suum*) (van Krimpen et al. 2010). These products potentially provide also antioxidative effects, enhance palatability, improve gut functions, or promote growth (Partanen, 2001; Namkung et al., 2004; Franco et al., 2005; KasproWicz-Potocka et al., 2009).

In conclusion, the above alternatives to antibiotics could be a useful tool for prevention and control diseases (especially PMWS) as well as for improvement of growth performance in organic pigs (Castro, 2005; Jacela et al., 2010).

Vaccinations against porcine parvovirus, *Escherichia coli*, *Mycoplasma hyopneumoniae*, PRRSV and Aujeszky have to be applied in regions with large number of conventional swine farms. In European countries some of the above vaccinations have good results in prevention of diseases (Hämeenoja, 2001; Baumgartner et al., 2001). The preventive vaccination programs are important especially in regions, where there are near to organic farms and other conventional swine farms.

Conclusion

Productivity growth in Greek organic pig farms can be increased by improving the living conditions of animals and the implementation of preventive measures (e.g., vaccination programs, treatments with phytotherapeutics) that reduce mortality rates (especially during the winter months). Disease prevention is

a key point in organic livestock production and for this reason the application of a health management program in organic pig farming is suggested. Furthermore, to ensure food safety of organic products, monitoring risk factors for diseases and to control these risks factors as a means to prevent diseases, are suggested the implementation of health management based on Hazard Analysis Critical Control Point (HACCP).

Uticaj upravljanja zdravstvenim stanjem životinja na organskim svinjarskim farmama u Grčkoj

V.G. Papatsiros

Rezime

U Grčkoj, organsko stočarstvo je počelo u 2002. godini, i od tada su učinjeni značajni koraci u pravcu povećane zainteresovanosti grčkih potrošača za organske proizvode tokom poslednje decenije. Ovaj rad ima za cilj ažuriranje informacija koje se odnose na organsku proizvodnju svinja u Grčkoj, koje se odnose na proizvodni sistem i najvažnije i najčešće faktore zdravstvenih rizika. Takođe, u ovom istraživanju predlaže se program upravljanja zdravljem životinja.

Najčešći zdravstveni problemi koji se pojavljuju na grčkim farmama za organsku proizvodnju svinja su respiratorni problemi, gastrointestinalni problemi, problemi sa papcima i kožom, parazitske infekcije i mortalitet prasadi. Program upravljanja veterinarskim zdravljem životinja na organskim farmama za proizvodnju farmi, uključujući i korišćenje alternativa za antibiotike (prebiotici, probiotici i fitogenici), antiparazitika, odgovarajućih vakcina (npr. protiv *E. coli*, *M. hyo*, PRRSV) i adekvatni program dezinfekcije (npr. kontrola štetočina korišćenjem deratizacionih preparata) može biti koristan instrument za prevenciju i kontrolu bolesti, kao i za poboljšanje proizvodnih performansi i porasta.

Kao zaključak, povećanje produktivnosti na grčkim organskim farmama za proizvodnju svinja se može ostvariti poboljšanjem uslova života životinja i implementacijom preventivnih mera (npr., program vakcinacije, tretmani sa fototerapeutičima) koji smanjuju stopu smrtnosti (posebno tokom zimskih meseci). Iz tog razloga primena programa upravljanja zdravljem zapata je neophodna na organskoj farmi za proizvodnju svinja.

References

ALEXOPOULOS C., GEORGOULAKIS I.E., TZIVARA A., KRITAS S.C. SIOCHU A., KYRIAKIS S.C. (2004b): Field evaluation of the efficacy of a

- probiotic containing *Bacillus licheniformis* and *Bacillus subtilis* spores, on the health status and performance of sows and their litters. *Journal of Animal Physiology & Animal Nutrition*, 88, 381-392.
- ALEXOPOULOS C., GEORGOULAKIS I.E., TZIVARA A., KYRIAKIS C.S., GOVARIS A., KYRIAKIS S.C. (2004a.): Field evaluation of the effect of a probiotic containing *Bacillus licheniformis* and *Bacillus subtilis* spores on the health status, performance, and carcass quality of grower and finisher pigs. *Journal of Veterinary Medicine A*, 51, 306-392.
- ALEXOPOULOS C., KARAGIANNIDIS A., KRITAS S.K., BOSCO C., GEORGOULAKIS I.E., KYRIAKIS S.C. (2001): Field Evaluation of a Bioregulator, Containing Live *Bacillus cereus* spores, On Health Status and Performance of Sows and their Litters. *Journal of Veterinary Medicine A*, 48, 137.
- ARSENOS G., BANOS G., VALERGAKIS G.E., FORTOMARIS P., ZYGOYIANNIS D. (2004): Proposed husbandry practices to ensure animal health and product quality in organic sheep and goat production systems. In: HOVI M., SUNDRUM A., PADEL S. (eds), *Organic livestock farming: Potential and limitations of husbandry practice to secure animal health and welfare and food safety*. Proceedings 2nd SAFO workshop, 25-27 March 2004, Witzenhausen. University of Reading, Reading, 101-113.
- BAUMGARTNER J., LEEB T., GRUBER T. & TIEFENBACHER R. (2001): Pig health and health planning in organic herds in Austria. Proceedings of the Fifth Network for Animal Health and Welfare in Organic Agriculture Workshop. Eds M. Hovi, M. Vaarst. Rødding, Denmark, 11-13 November, 2001. Reading, University of Reading. 126-131.
- BAUMGARTNER J., LEEB T., GRUBER T., TIEFENBACHER, R. (2003): Husbandry and animal health on organic pig farms in Austria. *Animal Welfare*, 12, 631-635.
- CARSTENSEN L., M. VAARST, A. ROEPSTORFF (2002): Helminth infections in Danish organic swine herds. *Veterinary Parasitology*, 106, 253-264.
- CASTRO M. (2005): Use of additives on the feeding of monogastric animals. *Cuban Journal of Agricultural Science*, 39, 439.
- CREUS E., PEREZ J. F., PERALTA B., BAUCCELLS F., MATEU E. (2007): Effect of acidified feed on the prevalence of Salmonella in market-age pigs. *Zoonoses and Public Health*, 54 (8), 314-319.
- DOA (Directorate of Organic Agriculture), Hellenic Ministry of Rural Development 2009. <http://www.minagric.gr/greek/3.6.4.html>.
- DOYLE M.E. (2001): *Alternatives to Antibiotic Use for Growth Promotion in Animal Husbandry. A Review of the Scientific Literature*. Madison, Wisconsin: Food Research Institute.

- EC (2004): 415 final. European Action Plan for Organic Food and Farming. Communication from the Commission [COM(2004) 415 final] of 10 June 2004 . Brussels, Commission of the European Communities.
- FEENSTRA A. (2000). A health monitoring study in organic pig herds. Darcof Report 2/2000, pp. 107-112.
- FRANCO L.D., FONDEVILA M., LOBERA M.B., CASTRILLO C. (2005): Effects of combinations of organic acids in weaned pig diets on microbial species of digestive tract contents and their response on digestibility. *Journal of Animal Physiology and Animal Nutrition*, 89, 88-93.
- GRATZ N.G. (1994): Rodents as carriers of disease. In: A.P. BUCKLE, R.H. SMITH (eds.), *Rodent pests and their control*. CAB International, Oxford, England, 85-108
- HAMEENOJA, P. (2001): Animal health and welfare – pig production. *Acta Veterinaria Scandinavica, Supplementum*, 95, 33-36.
- HIETT K.L., N.J. STERN, P. FEDORKA-CRAY, N.A. COX, M.T. MUSGROVE, S. LADELY (2002): Molecular subtype analyses of *Campylobacter* spp. From Arkansas and California poultry operations. *Applied and Environmental Microbiology*, 68, 6220-6236.
- JACELA J.Y., DEROUCHEY J.M., TOKACH M.D., GOODBAND R.D., NELSSSEN J.L., RENTER D.G., DRITZ S.S. (2010): Feed additives for swine: Fact sheets - prebiotics and probiotics, and phytogenics. *Journal of Swine Health and Production*, 18, 3, 132-136.
- KAMPSHOF J., STEVERINK M. (2001): Year results biovar study group 2001. <http://www.platformbiologica.nl/varkens/> Accessed 6 December 2004.
- KASPROWICZ-POTOCKA M., FRANKIEWICZ A., SELWET M., CHILOMER K. (2009): Effect of salts and organic acids on metabolite production and microbial parameters of piglets' digestive tract. *Livestock Science*, 126, 1-3, 310-313.
- KYRIAKIS S.C., GEORGOULAKIS I., SPAIS A., ALEXOPOULOS C., MILIOTIS CH.C., KRITAS S.K. (2003): Evaluation of Toyocerin, a probiotic containing *Bacillus toyoi* spores, on health status and productivity of weaned, growing and finishing pigs. *Asian-Australasian Journal of Animal Sciences*, 16, 9, 1326-1331.
- KYRIAKIS S.C., TSILOGIANNIS V.K., VLEMMAS J., SARRIS K., TSINAS A.C., ALEXOPOULOS C. (1999): The effect of probiotic LSP 122 on the control of the post weaning diarrhoea syndrome of piglets. *Research in Veterinary Science*, 67, 223-228.
- LAMPKI N., OLMOS S., LOWMAN S., VAN DIEPEN P. (2007): Statistical report on the development of organic farming in EU-15, Switzerland and Norway 1997-2006. D5 of EU-CEE-OFP Organic Farming Policy. University of Wales, Aberystwyth.

- http://www.irs.aber.ac.uk/EUCEEOFPE/euceeofp/pdf_files/European_organic_farming_statistics.pdf.
- LEEB T., BAUMGARTNER J. (2000): Husbandry and health of sows and piglets on organic farms in Austria. Animal health and welfare aspects of organic pig production. In: ALFÖLDI T., LOCKERETZ W., NIGGLI U. (eds), Proceedings of the 13th International IFOAM Scientific Conference, 28–31 August 2000, Basel.
- LEIRS H., LODAL J., KNORR M. (2004): Factors correlated with the presence of rodents in outdoor pig farms in Denmark and suggestions for management strategies. *NJAS – Wageningen Journal of Life Sciences*, 52, 145-161.
- LLORENS ABANDO L., ROHNER-THILEN E. (2007): Unterschiedliche Strukturen beim ökologischen Landbau in der EU-25. EUROSTAT. Available at: http://epp.eurostat.ec.europa.eu/cache/ity_offpub/ks-sf-07-069/de/ks-sf-07-069-de.pdf.
- MEAD P., SLUTSKER L., DIETZ V., MCCAIG L., BRESEE J., SHAPIRO C., GRIFFIN P., TAUXE R. (1999): Food-related illness and death in the United States. *Emerging Infectious Diseases*, 5, 607–625.
- MEERBURG B.G., BONDE M.K., BROM F.W.A., ENDEPOL S., JENSEN A.N., LEIRS H., LODAL, J., SINGLETON G.R., PELZ H.-J., RODENBURG T.B., KIJLSTRA A. (2004): Towards sustainable management of rodents in organic animal husbandry. *NJAS – Wageningen Journal of Life Sciences*, 52, 195-205.
- MEJER H., THAMSBORG S.M., ROEPSTORFF A., ERIKSEN L. (1999): Organic pigs have many intestinal worms, but what is the influence of them on animals. *Forskningssnytt*, 8, 15-18.
- MROZ Z. (2005): Organic acids as potential alternatives to antibiotic growth promoters for pigs. *Advances in Pork Production*, 16, 169-182.
- NAMKUNG H., LI M., GONG J., YU H., COTTRILL M., DE LANGE C.F.M. (2004): Impact of feeding blends of organic acids and herbal extracts on growth performance, gut microbiota and digestive function in newly weaned pigs. *Canadian Journal of Animal Science*, 84, 697-704.
- NANSEN P., ROEPSTORFF A. (1999): Parasitic helminths of the pig: factors influencing transmission and infection levels. *International Journal for Parasitology*, 29, 877-891.
- ØVERLAND M., KJOS N.P., BOR, M., SØRUM H. (2007): Organic acids in diets for entire male pigs. *Livestock Science*, 109, 1-3, 170-173.
- PAPATSIROS V.G., TZIKA E.D., PAPAIOANNOU D.S., ALEXOPOULOS C., TASSIS P.D., KYRIAKIS S.C., KYRIAKIS C.S. (2009). Effect of *origanum vulgare* and *allium sativum* extracts for the control of Proliferative Enteropathy in weaning pigs. *Journal of Polish Journal of Veterinary Science*, 12, 3, 407-414.
- PARTANEN K. (2001): Organic acids – Their efficacy and modes of action in pigs. *Gut Environment of Pigs*, (Ed. Piva, Back Knudsen, Lindberg). Nottingham University Press, 2001, 201-218.

- PIVA A., GRILLI E. (2007): Role of benzoic, lactic and sorbic acid in in vitro swine cecal fermentation. *Veterinary Research Communications*, 31, 1, 401-404.
- ROEPSTORFF A., JØRGENSEN R.J., NANSEN P., HENRIKSEN S.A., SKOVGAARD J., PEDERSEN J., ANDREASEN M. (1992): Parasites in organic pigs. Rapport over Projekt finansieret af Jordbrugsdirektoratet under Landbrugsministeriet. National Committee for Pig Production, Danish Bacon and Meat Council, Copenhagen, 36
- TAUXE R. (2002): Emerging food-borne pathogens. *International Journal of Food Microbiology*, 78, 31-41.
- TSILOYIANNIS V.K., KYRIAKIS S.C., VLEMMAS J., SARRIS K. (2001a): The effect of organic acids on the control of porcine post-weaning diarrhoea. *Research in Veterinary Science* 70, 287-293.
- TSILOYIANNIS V.K., KYRIAKIS S.C., VLEMMAS J., SARRIS K. (2001b) The effect of organic acids on the control of post-weaning oedema disease of piglets. *Research in Veterinary Science*, 70, 281-285.
- VAARST M., ROEPSTORFF A., FEENSTRA A., HOGEDAL P., LARSEN V.A., LAURITSEN H.B., HERMANSEN E. (2000): Animal health and welfare aspects of organic pig production. *Darcoff Report No 2/2000*, 77-78.
- VAN KRIMPEN M.M, BINNENDIJK G.P., BORGSTEEDE F.H.M., GAASENBEEK C.P.H. (2010): Anthelmintic effects of phytogetic feed additives in *Ascaris suum* inoculated pigs. *Veterinary Parasitology*, 168, 3-4, 269-277
- VERMEER H.M., ALTENA H., BESTMAN M., ELLINGER L., CRANEN I., SPOOLDER H.A.M., BAARS T. (2000): Monitoring organic pig farms in The Netherlands. In: *Proceedings of the 51st Annual Meeting of the European Association of Animal Production*, 21–24 August, The Hague. Wageningen Pers, Wageningen, 211.
- WINDISCH W., SCHEDULE K., PLITZNER C., KROISMAYR A. (2008): Use of phytogetic products as feed additives for swine and poultry. *Journal of Animal Science*, 86, 14, 140-148.
- WINGSTRAND A., DAHL J., LO FO WONG D.M.A. (1999): Salmonella-Prevalences in Danish Organic, Free-range, Conventional and Breeding Herds. In: *Proceedings of the 3rd International Symposium on the Epidemiology and control of Salmonella in Pork*. Washington DC, USA, 186-189.
- ZERVAS D. (2007): Consumers' nutritional habits and shopping preferences: a survey in Greek consumers. Department of Dietetics and Nutritional Science, Harokopeion University, Athens.
- ZIMMERMANN B., BAUER E., MOSENTHIN R. (2001): Pro - and prebiotics in pig nutrition – potential modulators of gut health? *Journal of Animal and Feed Sciences*, 10, 47-56.