**Effects of Oregano Essential Oil on Pigs**

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# **Τίτλος μελέτης: *Effects of dietary oregano essential oil supplementation on the stress response, antioxidative capacity, and HSPs mRNA expression of transported pigs***

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**Περίληψη μελέτης:** Η μεταφορά των χοίρων πριν τη φραγή προκαλεί, πολλές φορές οξύ άγχος στους χοίρους με αποτέλεσμα την υποβάθμιση των χαρακτηριστικών του σφάγιου. Στην παρούσα μελέτη βρέθηκε ότι η προσθήκη αιθέριου ελαίου ρίγανης στη διατροφή των χοίρων είχε **θετική επίδραση στο παραπάνω φαινόμενο**. Ειδικότερα, οι μελετητές παρατήρησαν πως **το ριγανέλαιο συνέβαλε στη μείωση του άγχους μεταφοράς**. Επίσης, παρατηρήθηκε **μειωμένη οξείδωση των λιπών στο κρέας**.

**Abstract:** Transportation stress affects carcass quality, metabolism and immune function. The utilization of feed additives is a possible strategy of mitigating physical and psychological stresses after animal transportation. Oregano essential oil (OEO) is an aromatic plant extract that mainly contains carvacrol and thymol. However, the effects of dietary supplementation with OEO for the welfare of transported pigs are limited. This study aimed to investigate the effect of OEO on alleviating stress and increasing antioxidative capacity after the transportation of finishing pigs. 180 crossbred pigs were randomly allocated to 1 of 3 diets: the basal diets, 200 mg kg1 vitamin E (VE), or 25 mg kg1 OEO. Each group was divided into two subgroups: no stress (NS) or transportation stress (TS) after 28 days. Here we report that serum cortisol and norepinephrine concentrations of transported pigs were significantly reduced (Po0.05) in OEO diet. Reactive oxygen species (ROS) and malondialdehvde (MDA) were significantly increased in the serum (Po0.05) and liver (Po0.05) of TS pigs. Serum glutathione peroxidase (GSH-Px) was markedly raised (P¼0.01) in dietary treatment. Liver SOD was dramatically raised no matter transportation (Po0.01) or dietary treatment (P¼0.01). Liver heat shock protein (HSP) 27 and HSP90 were significantly increased (Po0.01) after transportation. These results indicated that OEO is beneficial in alleviating transportation stress and improving antioxidative activity, similar to VE.

**Conclusions:** The results of the present investigation showed that dietary OEO and VE supplementation may alleviate TS and reduce lipid oxidation. Supplementation with OEO and VE both reduced serum stress-response hormones cortisol levels compared with the control diet, but only OEO can reduced norepinephrine levels in TS pigs. Dietary VE and OEO supplementation reduced MDA levels and partly increased antioxidant enzyme activity. However, supplemental VE and OEO did not significantly affect HSP mRNA expression in the liver of finishing pigs. Overall, OEO may be a potential alternative for mitigating TS and enhancing antioxidative capacity, similar to VE.

# **Τίτλος μελέτης: *Effects of dietary oregano essential oil and vitamin E supplementation on meat quality, stress response and intestinal morphology in pigs following transport stress***

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**Περίληψη μελέτης:** Οι μελετητές χρησιμοποιήσαν αιθέριο έλαιο ρίγανης (Origanum vulgare) σε μορφή σκόνης για να ελέγξουν αν επηρεάζει το stress μεταφοράς και την ποιότητα του κρέατος. Παρατηρήθηκε μεταξύ άλλων σημαντική μεταβολή συγκριτικά με το δείγμα αναφοράς. Οι χοίροι που είχαν στην τροφή τους ριγανέλαιο σε ποσότητα 25 *mg/kg τροφής* σημείωσαν **χαμηλότερα ποσοστά άγχους κατά τη μεταφορά τους**. Επίσης, **παρατηρήθηκε μικρότερη ποιοτική υποβάθμιση του παραγόμενου κρέατος** με τη χρήση ριγανελαίου, συγκριτικά με το δείγμα ελέγχου.

**Abstract:** This study investigates the effects of dietary oregano essential oil (OEO) and vitamin E (Vit E) supplementation on meat quality, stress response and intestinal morphology in pigs following transport stress. A total of 288 finishing pigs were randomly assigned to three groups: a basal diet or a basal diet supplemented either with 200 mg/kg Vit E or 25 mg/kg OEO. After a 28-day feeding trial, total of 132 finishing pigs according diet and transport stress were assigned to one of four treatment groups: 1) control treatment without transport stress (Control group), 2) control treatment with 5-hr transport stress (Negative group), 3) Vit E treatment with 5-hr transport stress and 4) OEO treatment with 5-hr transport stress. Transport stress pigs had lower muscle 45 min pH (pHi) and higher drip loss than control pigs. Dietary OEO and Vit E supplementation significantly increased 45min pH under transport stress, and the OEO groups produced lower 24-hr drip loss values (P< 0.05), and decreased Hsp 27 (heat shock protein 27) and Hsp 70 (heat shock protein 70) mRNA expression in the muscle (P < 0.05). Additionally, histological analysis revealed intestinal epithelial damage in transport stress pigs that was reversed by dietary supplementation with OEO. In conclusion, supplementation with dietary OEO may be superior to supplementation with dietary Vit E in alleviating the meat quality, stress response and intestinal morphology of pigs after challenge due to transportation stress.

**Conclusions:** In the present study, the dietary administration of OEO had positive effects on growth performance in the finishing period for pigs. Under the transportation procedures used in the study, OEO was superior to Vit E in decreasing the stress response, thereby reducing transportation-induced intestinal injury and improving meat quality. We found that OEO can act as an efficient dietary supplement to alleviate transport stress in finishing pigs.

# **Τίτλος μελέτης: *Oregano essential oil as food additive for piglets: antimicrobial and antioxidant potential***

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**R. Bras. Zootec., v.39, n.8, p.1761-1767, 2010**

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**Περίληψη μελέτης:** Στην παρούσα εργασία έγινε έλεγχος της πιθανής θετικής επίδρασης του αιθέριου ελαίου ρίγανης σε χοιρίδια. Ιδιαίτερη σημασία δόθηκε στην αντιοξειδωτική και αντιμικροβιακή δράση του ριγανελαίου. Χρησιμοποιήθηκε ποσότητα ριγανελαίου σε ποσοστό 0.003%. Παρατηρήθηκε, πειραματικά, ότι το αιθέριο έλαιο ρίγανης έχει **καλή αντιοξειδωτική δράση**. Ακόμη, οι μελετητές παρατήρησαν ότι το ριγανέλαιο έχει **σημαντική αντιμικροβιακή δράση** όταν χρησιμοποιείται ως πρόσθετο στη διατροφή χοιριδίων. Τέλος, δεν βρέθηκε σημαντική επίδραση στην πρόληψη της διάρροιας και στην επίδοση ανάπτυξης των χοιριδίων με τη χρήση αυτής της ποσότητας ριγανελαίου. Ωστόσο, άλλες μελέτες έχουν δείξει ότι η χρήση ριγανελαίου μπορεί να λειτουργήσει θετικά όσον αφορά τη διάρροια σε χοίρους, καθώς και στην αύξηση του σωματικού τους βάρους.

**Abstract:** This study aimed to investigate the effect of dietary supplementation of oregano essential oil on the performance and on the occurrence of diarrhea in weanling pigs, as well as its antioxidant and antimicrobial activity evaluated in vitro. It was compared four treatments (diets): negative control; positive control, 0.5% ZnO (preventive diarrhea) + 0.05% zinc acitracin (growth promoter); or 0.003% of essential oil of oregano, combined or not with preventive of diarrhea. Weight gain, feed intake and feed conversion were evaluated from 27 (weaning) to 62 days of age of the animals, and the occurrence of diarrhea was evaluated on the first 14 days of the experiment. The positive control diet and the oregano oil + zinc oxide diet were the ones that provided the best zootechnical performance. The number of piglets with diarrhea, as well as the duration of diarrhea, were lower in animals fed positive control and oregano oil + zinc oxide diets. Oregano oil had in vitro bacteriostatic action on all the tested microorganisms and bactericidal action against four bacteria. The in vitro antioxidant activity of oregano oil was 98.88% through linoleic acid/β-carotene system methodology, and 174.17 mg/mL by the DPPH method, expressed as CE50. Oregano oil shows potent antioxidant effect and a strong antimicrobial activity, however, it does not improve the zootechnical performance neither it is efficient in preventing diarrhea in weanling pigs.

**Conclusions:** The antioxidant and antimicrobial activities evaluated in vitro show that essential oil of oregano is a potent antioxidant, especially in inhibiting the oxidation of fatty acids and with strong antimicrobial activity. However, the essential oil of oregano at the studied dose does not improve growth performance neither prevent diarrhea in weaned pigs.

# **Τίτλος μελέτης: *Meat Quality and Lipid Oxidation of Pork after Dietary Supplementation with Oregano Essential Oil***

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**Περίληψη μελέτης:** Οι μελετητές, στην παρούσα εργασία, παρατήρησαν την επίδραση διαφορετικών ποσοτήτων αιθέριου ελαίου ρίγανης σε χοίρους. Συμπερασματικά, το ριγανέλαιο λειτούργησε ως **αντιοξειδωτικός παράγοντας**. Επίσης, **βελτίωσε την ποιότητα του παραγόμενου κρέατος**. Οι ερευνητές προτείνουν τη χρήση αιθέριου ελαίου ρίγανης σε ποσότητα **1000 ppm** στη δίαιτα χοίρων για καλύτερο ποιοτικά κρέας και για τον περιορισμό της οξείδωσης του λίπους. Τέλος, **σε αυτή την ποσότητα παρατηρήθηκε η καλύτερη επίδοση του ριγανελαίου**.

**Abstract:** This study was carried out to determine the effects of diet supplementation with oregano (Lippia graveolens) essential oil (OEO) on meat quality and lipid oxidation in swine. A total of 48 pigs (Landrace × Yorkshire) was randomly assigned to one of four experimental groups during the finishing period. Each group was fed a commercial diet supplemented with either 0 ppm (control), 1000 ppm, 2000 ppm or 3000 ppm OEO. Pigs were killed at 110 kg and meat quality was assessed over a 16 day storage period. With storage time, the water holding capacity of female meat increased (P ≤ 0.05) and the drip loss of both male and female meat decreased (P ≤ 0.001); OEO did not have a significant (P ≥ 0.05) effect on either factor. Lipid oxidation of meat from the 1000 ppm group was lower than that of control samples at any storage period. The addition of 1000 ppm OEO to pig diet could be recommended for the production of meat of good quality and minimum lipid oxidation.

**Conclusions:** The present study contributes to a better understanding of the relationship between oregano essential oil (OEO) and quality characteristics of pork. For pork quality special attention should be put on the optimal OEO dose and storage time to ensure higher water holding capacity, lower drip loss and the inhibition of lipid oxidation. Meat traits influenced by sex, storage time and OEO doses. An important conclusion was that lipid oxidation in meat was inhibited most by 1000 ppm OEO. The meat industry can benefit substantially by taking into account the OEO dose supplemented to pigs.

# **Τίτλος μελέτης: *Oregano essential oil improves piglet health and performance through maternal feeding and is associated with changes in the gut microbiota***

*(Published: 04 January 2021)*

**Animal Microbiome**

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**Περίληψη μελέτης:** Η επίδραση του αιθέριου ελαίου ρίγανης στη μικροχλωρίδα του εντέρου των χοίρων παραμένει ασαφής. Οι συγγραφείς προσπάθησαν μέσω της μελέτης τους να ελέγξουν την επίδραση του ριγανελαίου στην **επίδοση-παραγωγικότητα** και στην **μικροχλωρίδα των κοπράνων** των χοιρομητέρων και των χοιριδίων. Παρατήρησαν ότι τα χοιρίδια που μεγάλωναν με χοιρομητέρες που τρέφονταν με αιθέριο έλαιο ρίγανης, παρουσίαζαν **μεγαλύτερο βάρος από τη γέννηση μέχρι τον απογαλακτισμό τους**. Μία βδομάδα μετά τη γέννηση τους, **τα χοιρίδια** αυτά **ήταν πολύ βαρύτερα**, με **μεγαλύτερο ημερήσιο μέσο όρο πρόσληψης βάρους** μέχρι τον απογαλακτισμό. Δέκα εβδομάδες μετά τον απογαλακτισμό και κατά τη σφαγή, οι χοίροι αυτοί ήταν **βαρύτεροι, με μικρότερες διακυμάνσεις σε βάρος μεταξύ τους.** Οι μελετητές καταλήγουν στο ότι το αιθέριο έλαιο ρίγανης μπορεί να βοηθήσει στο πρόβλημα που αντιμετωπίζει η βιομηχανία σχετικά με την αντιμικροβιακή αντίσταση και να βελτιώσει την υγεία του εντέρου των ζώων ως φυσικό μέσο.

**Abstract:** With a growing demand for safe and sustainable alternatives to antimicrobials, functional feed ingredients such as plant essential oils have been evaluated for their potential to improve gut health. Amongst these, oregano essential oil (OEO) with the main active compounds carvacrol and thymol has been reported to have antimicrobial and antioxidative properties resulting in improved intestinal barrier function and growth in pigs and poultry. However, its impact on the gut microbiota still remains unclear. The aim of this study was to examine the effect of an oregano essential oil phytobiotic on sow and piglet performance and faecal microbiota. Piglets from OEO supplemented sows were significantly heavier at one week of age and showed a trend for improved average daily weight gain from birth to weaning. Post-weaning, maternally supplemented piglets were numerically heavier at 10 weeks post-weaning and at slaughter with a reduced variability in bodyweight. Health records showed that piglets in the OEO supplemented litters had significantly reduced incidence of therapeutic treatment and reduced mortality. In both sows and piglets, the structure and composition of the faecal microbiota varied considerably over time. Sows supplemented with OEO during lactation showed an increase in the relative abundance of Lactobacillaceae family. In addition, there was an increase in the relative abundance of families known to be important in fibre digestion (Fibrobacteriaceae and Akkermansiaceae). Analysis of piglet microbiota at two weeks and four weeks of age revealed a relative decrease in Enterobacteriaceae while butyrate producers (Lachnospiraceae family) were increased at both timepoints.

**Conclusions:** We hypothesise that the effects observed from this study were exerted through modulation of the gut microbial communities in the sow and her offspring through maternal microbial transfer. Understanding the link between the gut microbiota and dietary factors represents a keystone to improving health and performance for sustainable pig production. Reducing antimicrobial usage can help to reduce the risk of antimicrobial resistance (AMR) which is a global focus for animal production.

# **Τίτλος μελέτης: *Application of plant essential oils in pig diets***

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**Feed additives (**Aromatic Plants and Herbs in Animal Nutrition and Health

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**Περίληψη μελέτης:** Σύμφωνα με τους συγγραφείς, τα αιθέρια έλαια επιδρούν θετικά στην πέψη και στη ρύθμιση της μικροχλωρίδας του εντέρου, δρουν ως αντιοξειδωτικά, βοηθούν στη λειτουργία του εντέρου και γενικά προωθούν την ανάπτυξη και ευημερία των χοίρων. Πιο συγκεκριμένα, οι **αντιοξειδωτικές ιδιότητες του αιθέριου ελαίου ρίγανης** έχουν παρατηρηθεί από πολλές σύγχρονές μελέτες. Κατά τη μεταφορά τους, οι χοίροι υφίστανται οξειδωτικό στρες με μεγάλο αριθμό ελεύθερων ριζών, γεγονός που προκαλεί σημαντική υποβάθμιση του τελικού προϊόντος. Έτσι, η **υψηλή αντιοξειδωτική ικανότητα** του αιθέριου ελαίου ρίγανης βοηθά στην **πρόληψη** αυτής **της υποβάθμισης του κρέατος** και την **εξομάλυνση των αρνητικών επιπτώσεων του στρες των χοίρων κατά τη μεταφορά τους**.

**Abstract:** This chapter summarizes current research on the efficacy, possible mechanisms, and feasibility in the application of phytogenic compounds as feed additives in pig diets. Phytogenic compounds are defined as plant-derived natural bioactive compounds with positive effects on animal growth and health, and are often applied to essential oils (EOs), botanicals, and herbal extracts. Some phytogenic compounds have a variety of functions, including antimicrobial, antioxidative, antiinflammatory, and immunoregulatory effects. The commercial phytochemicals applied in pig production including oregano EO and cinnamaldeyde have been shown to improve growth performance and intestinal health in weaned piglets, reproductive performance in sows, and semen quality in boars. Therefore, several phytochemicals are regarded as potential alternatives to antibiotics in pig production. However, there has been a lack of consistency in laboratory results due to the varied composition of products, dosages, and duration of treatment. The integration of multi-omics information may help to understand the mechanisms underlying phytogenic compounds' functions and subsequently guide their effective use.

**Conclusions:** EOs are naturally occurring phytochemicals which have various applications and have long been known and used throughout the world for treatment of many diseases. EOs have positive effects on digestion, gut microbial community, antioxidant effects, barrier function of the intestine, growth performance and welfare. These characteristics could be a useful alternative to AGPs in animal diets. EOs can increase the performance of swine and growing finishing pigs, alleviate transport stress in finishing pigs, and increase reproductive performance of boars and sows.

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