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Biological functions and health promoting effects of brown seaweeds in swine nutrition

Abstract

Marine macroalgae could be an important supplement in animal nutrition for their health-promoting effects. In recent years, the search of natural substances as substitutes of prophylactic antibiotics increased. Seaweeds, in particular brown algae, possess distinctive compounds such as laminarin and fucoidan, studied for their biologically active functions. Recent studies have shown that these bioactive components can positively affect the health and wellbeing improving intestinal mucosa metabolism, and have anti-microbial, anti-inflammatory and immunomodulatory effects. The present work is focuses on the health-promoting activities of seaweeds, in particular brown algae, as swine dietary supplement.

Keywords: brown seaweed, health, swine, dietary supplementation

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Introduction

Recently, prophylactic use of antibiotics in livestock have been banned by European Community with the consequence of a growing research towards new, safe and natural ingredients, like plant extract, that would have antimicrobial properties.[1] In this context, seaweed extracts have assumed great importance in animal nutritionfor the high content in bioactive molecules.[2] Seaweed or marine macroalgae are divided in three categories: red (*Rhodophyta*), brown (*Phaeophyta*) and green (*Chlorophyta*).[3]

The seaweeds have shown interest as functional dietary ingredient due to its several health benefits related to their content of sulfated polysaccharides, phlorotannins, diterpenes, omega-3 PUFAs, minerals and vitamins.[4,5] In particular brown macroalgae have the higher content of water solubles polysaccharides, laminarin and fucoidan, compared to red and green seaweeds[6] which contain phenol component with higher free-radical scavenging properties.[3]

The following biologically active functions of brown seaweeds are discussed in the present study: prebiotic function such as anti-microbial activity and improvement of digestibility; antioxidant, anti-inflammatory, and immunomodulatory activities.

Prebiotic function

Anti-microbial activity

Seaweeds are rich in sulfated polysaccharides in particular laminarin and fucoidan, that can act as prebiotics with positive effect on gut health.[7,8] These compounds are effective against Gram positive bacteria,[9,10] and Gram negative such as *Escherichia coli*.[11] Laminarin consists mainly of β-glucans that reveal prebiotic function, increasing *Bifidobacteria* and *Lactobacilli* species in the large intestine.[12] Gut health is indirectly modulated by laminarin, with the microbial production of short-chain fatty acids (SCFA), in particular butyrate.[13–14] This SCFA is well known to be the main energy source for intestinal cells, stimulating cell growth.[15] Moreover, fucoidans are also studied for their antibacterial properties.[16]

Recent study[17] showed that dietary supplementation with laminarin (300mg/kg) and fucoidan (236mg/kg), independently or in combination, for 21days increased daily gain in weaned piglets. In particular, authors found that laminarin was able to reduce in *Escherichiacoli* population.

Similarly, Reilly et al.[18] found that dietary supplementation with laminarin (1.5g/kg) had a positive effect on the bacteria population *Lactobacilli*, *Enterobacteria* and *Bifidobacteria*, in weaned pigs. Moreover, recently seaweed has been considered as a dietary supplementation in piglets, modulating at weaning the negative changes in gut morphology and microbial populations.[19]

Influence on digestibility

McAlpine et al.[20] have highlighted the effect of the seaweed extract on diet digestibility. The authors found that inclusion of laminarin (300mg/kg) and fucoidan (240mg/kg) in weaned piglets increased the coefficient of apparent total tract digestibility (CTTAD). The piglets fed with seaweed extract had a higher CTTAD of nitrogen, dry matter, and non-digestible fiber or NDF compared with pigs fed by basal diet. Also Gahan et al. [21] showed that laminarin and fucoidan mixture in piglet diet (4g/kg feed) could replace lactose dietary supplementation (60g/kg) without adversely affecting growth rate and feed efficiency in antibiotic free diet. Another study[22] reveals that the dietary supplementation with laminarin (300mg/kg feed) has a positive effect on diet digestibility, enhancing growth performance in pig.

Antioxidant function

Brown algae have antioxidant properties due to the presence of phenols, flavonoids, tannins, and phlorotannins.[23] O'Sullivan et al.[24] studied *in vitro* antioxidant effects in five different brown algae. They found that two brown algae, *Pelvetiacanaliculata* and *Fucus serratus*, prevent H_2O_2-mediated superoxide dismutase (SOD) depletion and ensurea DNA protective effects. In another study Zhang et al.[25] reported that dietary supplementation with *Porphyra* in mice (200mg/kg feed) reduce the risk of lipid peroxidation in the aging process. In contrast, a recent study reported that the dietary inclusion of different levels of seaweed extract (from 2.5g/kg to 10g/kg feed) did not enhance plasma oxidative status.[26]

Anti-inflammatory

Brown macroalgae showed also anti-inflammatory effects.[27] In fact, a lower expression of pro-inflammatory cytokines in the colon was observed in piglets after laminarin dietary supplementation.[28] Moreover, laminarin dietary supplementation (600mg/kg) significantly increased gut mucins gene expression (MUC 2 and 4), with a protective effects on epithelial cells.[29] The *ex vivo* anti-inflammatory response of extracts of brown seaweed on swine colon was also evaluated. Colon samples were homogenized and mixed with 10µg/ml of bacterial lipopolysaccharides by *Escherichia coli* to induce a pro-inflammatory responsein relation to seaweed extract inclusion (1mg/ml). The results demonstrated that extract of brown algae had anti-inflammatory activity reducing the pro-inflammatory cytokine response.[2]

Immunomodulatory

Laminarin over that antimicrobial has also immunomodulatory function.[30] In a recent trial Leonard et al.[31] studied the effect of seaweed extract (1.8g/day) in the diet of pregnant sows. They found an increase of immunoglobulin G (IgG) in the colostrum of sows fed with seaweed and consequently an increase of serum IgG in piglets. Also Katayama et al.[32] observed that dietary supplementation with 0.8% of seaweed extract increased immunoglobulin A and G, enhancing the immune system in pigs.

Conclusion

The biological activities of brown seaweeds could be used to improve health and welfare of pig. The prebiotic effect and the antimicrobial activity of laminarin and fucoidan may are beneficial for the preventive treatment of gastrointestinal diseases and to enhance diet digestibility in the post-weaning piglet. Moreover, laminarin exerts an anti-inflammatory activity, reducing the pro-inflammatory cytokine response. The brown seaweed dietary supplementation might positively affect immune system, enhancing immunoglobulin production. In conclusion the bioactive components in seaweed extract, revealed beneficial effects and can be used as dietary supplement in pig to sustain the production, enhancing health.

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Conflict of interest

Author declares that there is no conflict of interest.

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