TOWARDS SUSTAINABLE PRODUCTION: PORK QUALITY OF ANIMALS FED ALTERTERNATIVE PROTEIN SOURCES

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Abstract – This paper investigates the effects of the substitution of soymeal with Spirulina or *Hermetia illucens* in pork diets on the colour development, oxidative stability, and storage loss of pork chops packaged using highly oxygenated modified atmosphere packaging or vacuum bag packaging for either 3, 7, or 14 days. Although the alternatively-fed products differed from the traditionally-fed soy animals in terms of storage losses, oxidative stability, and lean colour, the differences are small and unlikely to influence overall consumer-perceived product quality.

Key Words – Hermetia illucens, pork quality, Spirulina

I. INTRODUCTION

Soybeans are a widely used dietary protein source (DPS) in livestock diets; the European Union relies on soybean imports for 40% of animal-fed protein [1]. In Europe, concerns regarding the cultivation and use of soybeans are mounting, particularly regarding world market power and the sustainability of production. To address these concerns, alternative DPS for livestock are desirable. *Arthrospira platensis* (commonly referred to as Spirulina), a cyanobacterium, has an average protein content of ~63% and is high in poly-unsaturated fats, especially γ – linolenic acid [2]; however, Spirulina may affect lean meat colour, as has been shown in broiler production, due to its high content of carotenoids and chlorophyll [3]. *Hermetia illucens* (i.e., the black soldier fly or Hermetia) is another potential DPS for livestock. The larvae, which are usually ground into meal, contain ~42% protein [4]; however the substrate used to fatten the larvae can affect the end product quality [5]. The effects Spirulina- and Hermetia-based feeds have on meat quality has not been thoroughly examined. This study focuses on ascertaining the effect of Spirulina- or Hermetia-based feeds on meat quality and the role that product packaging and storage duration may play.

II. MATERIALS AND METHODS

Twenty-three barrows (Pietrain x (Large White x Landrace)) were divided into three groups: 8 Spirulina-fed, 7 Hermetia-fed, and 8 soy-fed (control) animals. Starting at 25 kgs, the treatment groups were fed the respective experimental diets where 50% of the soy protein was substituted out for either Spirulina powder or Hermetia defatted-larval meal, or the control diet (100% soy protein). At ~110 kg the animals were slaughtered and butchered the next day. The left *longissimus thoracis et lumborum* was removed and divided into steaks 2 cm thick. Six steaks per animal were packaged in either highly oxygenated modified atmosphere packaging (HiOx MAP; 80% oxygen, 20% carbon dioxide) or vacuum bag packaging for either 3, 7, or 14 days. Steaks were monitored for lean colour development (Konica Minolta Chroma-Meter), storage loss (weight loss before and after storage), and lipid oxidation [6]. Statistical testing was carried out using SPSS 24.0; data were checked to meet the assumptions and a mixed factorial ANOVA was conducted, considering dietary protein source (DPS) as between-subject factor and number of packaged days and type of packaging (PACK) as the within-subject factors.

III. RESULTS AND DISCUSSION

Table 1 outlines the effects of DPS and packaging over time, as well as the relevant interaction terms. The Time, PACK*DPS and the Time*PACK terms are significant for lipid oxidation. The latter and former are to be expected, given that the HiOx environment induces lipid oxidation. The second is more surprising, given that the highest mean TBARS value is found for Hermetia-fed meat that was vacuum-bag packaged; however preliminary results indicate that the Hermetia-fed product is highest in poly-unsaturated fatty acids.

Table 1: Factor significance on lipid oxidation, storage loss and colour
*p<0.05, **p<0.01, p<0.001

	TBARS	Storage Loss (%)	L*	a*	b*
DPS	-	*	*	**	**
PACK	-	**	***	***	***
PACK*DPS	*	-	-	*	-
Time	*	-	**	-	**
Time*DPS	-	-	-	**	*
Time*PACK	*	-	*	***	***
Time*PACK*DPS	-	*	-	**	*

Hermetia-fed products exuded the least moisture (1.4% less than the control). Vacuum bag samples exuded on average 1.5% more moisture than their HiOx MAP counterparts. The L* (lightness) and a* (redness) values are significantly different for DPS and packaging groups. Hermetia-fed samples had the lowest L*-values (4.3 points darker than the control). Both the Spriulina and Hermetia groups had values below the control for a* and b* (ca. 1 point lower across groups and variables). Lightness of HiOx MAP samples' was on average higher than those of the vacuum-bag packed samples. As to be expected, the HiOx MAP packaged samples had also higher redness values. The samples all decreased in lightness over time; however with the exception of the Hermetia-fed products all the colour differences are under 2 points; therefore the slight differences are likely not noticeable to consumers.

IV. CONCLUSION

Spirulina and Hermetia could replace soymeal in pork diets without affecting key quality attributes (i.e., drip loss, color) perceptible to consumers in the end packaged product. The current practice of HiOx MAP packaging may be advantageous for pork fed with alternative protein sources, as it exhibited reduced storage losses as compared to vacuum packaging; however, lipid oxidation remains a hurdle overall if products are to be packaged for longer periods of time and specifically regarding alternative protein sources. Consumer acceptance in non-hypothetical choice tests and consumer product testing are planned for future studies to ensure that the sensory quality of alternative protein-fed pork has not been compromised.

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