71st ICoMST
GIRONA - CATALONIA - SPAIN
3rd-8th August - 2025

EVALUATING *NANNOCHLOROPSIS OCEANICA* AS A SOYBEAN PROTEIN REPLACEMENT IN POULTRY FEED: GROWTH PERFORMANCE AND MEAT QUALITY ANALYSIS

Fabio Fanari[1*], Joel Gonzalez[1], Luis Guerrero[1], Anna Claret[1], Borja Vila[2], M. Castellari[1]

[1] IRTA Food Industries, Monells, Spain.

[2] IRTA Animal Nutrition, Constanti, Spain

*fabio.fanari@irta.cat

I. INTRODUCTION

The use of human-edible materials like soy in animal feed raises several concerns since it contributes to high greenhouse gas emissions and requires significant land and water use for agriculture. For this reason, research is exploring alternative ingredients like microalgae, which are rich in proteins, unsaturated fatty acids, vitamins, and antioxidants, offering nutritional and environmental benefits [1]. Microalgae require less land and water and can be grown using wastewater and carbon dioxide. Species like *Nannochloropsis* are promising due to their high content of PUFAs, antioxidants, and vitamins [2]. Moreover, their use for human consumption is approved but only in limited amounts, thus making them uncompetitive with human food raw materials. This article aims to evaluate the feasibility of formulating a poultry feed in which 30% of the crude protein from soybean meal is replaced by *Nannochloropsis oceanica* (*N. Oceanica*) single-cell ingredients. The growth parameters of the animal have been evaluated with in vivo trials in comparison with a traditional diet uniquely based on soy as protein source. Additionally, the effect of diets on meat quality was assessed by evaluating nutritional composition (including fatty acid profile and carotenoid content), visual aspect, instrumental texture, physicochemical and microbiological stability, and sensory parameters.

II. MATERIALS AND METHODS

For feed validation, the Brill™ Formulation program was used, and the Aviagen “Ross308 2019 all veg” requirements were used for feed formulation. The criteria for microalga inclusion in the feed’s formula were replacing 30% of the crude Protein coming from soybean meal (4% of 13.5% total protein). Complete feeds were prepared using a double ribbon 500 L horizontal mixer (6 minutes mixing time). All ingredients except minerals, vitamins, amino acids, and fat were ground in a hammer mill to pass through a 3 mm sieve. Minerals, amino acids, vitamins, and fat were directly added to the mixer. A total of 90 poultries were reared in a commercial farm. A Randomized Complete Block Design was used, distributing the animals in two treatments: the control group, fed with conventional feed, and the “NO” group, raised with *N. Oceanica* enriched feed. Each formulation was randomly assigned to 9 cages (1 m^2) with 5 Ross308 male broiler chickens each. Feeds were provided from the start of the study upon arrival from the hatchery and for 35 days. Performance (body weight and yield) was assessed at 35 days. A total of 36 chickens were selected for meat quality analysis: 18 for the control and 18 for the NO treatment. The animals were slaughtered in a commercial abattoir, and the carcasses were delivered to IRTA facilities in a refrigerated transport at 4°C. Specifically, proximate composition, fatty acid profile, carotenoid content, pH, electrical conductivity, instrumental colour (CIELab), drip loss, and texture were evaluated on chicken breast. Additionally, the shelf-life was studied by monitoring the visual perception of colour stability and the olfactory evaluation by experienced technicians, the gas composition within the tray, the pH, the instrumental colour, the thiobarbituric acid reactive substances (TBARS), and the microbiological counts at 4 different times up to 9 days post-packaging.

III. RESULTS AND DISCUSSION

In terms of growth performance (carcass and breast weight and yield), the microalgae diet presented slightly lower but significantly different mean values of all the parameters. Talking about the physicochemical parameters, the main differences were observed in colour CIEL*a*b* coordinates. Differences were concentrated especially in the intensity of yellow (b*), which was higher for the microalgae treatments both in skin and breast (see Figure 1). Regarding the breast colour, a significant increase in redness and a concomitant increase in green hues (a*) was also observed. Regarding all the other parameters, pH, electrical conductivity, drip loss, texture, and shelf-life parameters (colour stability, oxygen and carbon dioxide composition within the tray, olfactory evaluation, pH, TBARS, and microbiological growth), no significant differences were observed. Nutritional composition revealed significant differences with higher content of carotenoids and n-3 fatty acids, which confer to the meat a higher nutritional value.

Finally, the sensory evaluation showed no differences in smell, taste, texture, and visual aspect, with the only exception being the observed exudate amount, which was evaluated significantly lower in microalgae treatment.

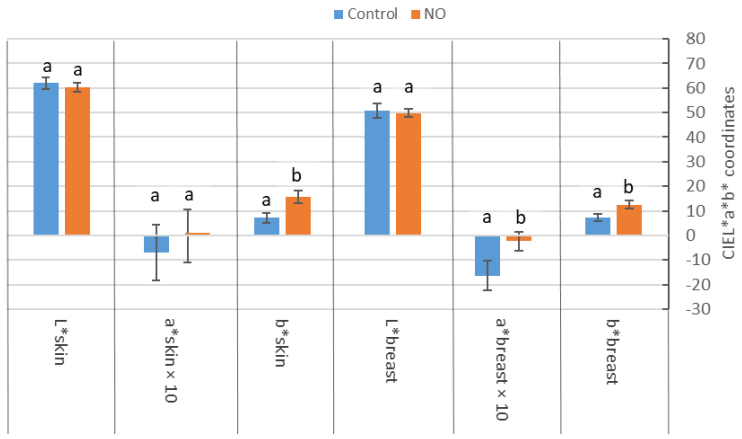


Figure 1. Coordinates in the CIEL*a*b* space, comparison between control treatment and *N. Oceanica* one (NO). Different letters for the same parameter indicate significant differences between the two treatments.

Table 1 – Nutritional composition of chicken breast (mean ± std) as a function of the treatment: control, and *N. Oceanica* one (NO). Asterisk * indicates parameters for which significant differences were observed between the two treatments.

Parameter	Control	NO
Protein (g/100g)	22.47 ± 0.58	22.78 ± 0.33
Fat (g/100g)	1.02 ± 0.44	0.78 ± 0.17
of which saturated (%)	41.53 ± 2.64	38.66 ± 3.17
of which n-3* (%)	2.67 ± 0.15	4.03 ± 0.11
Moisture (g/100g)	75.32 ± 0.89	75.65 ± 0.76
Ashes (g/100g)	1.34 ± 0.03	1.33 ± 0.04
Carotenoids* (g/kg)	0.23 ± 0.09	1.29 ± 0.17

IV. CONCLUSION

Although the growth performance was slightly negatively decreased in microalgae-including diet, the increase in bioactive and antioxidant compounds (carotenoids and n-3 fatty acids) in the meat opens interesting opportunities for the valorisation of microalgae in poultry feed. The changes in colour with increase, especially of yellowness, are to be evaluated because, depending on the country of sale and personal preferences, they could be evaluated positively or negatively. The absence of differences in the sensory parameters and, in general, no negative effect on shelf life and stability are also positive. One of the major problems of the development of microalgae-based feeds remains the cost. Scaling up the production of algae biomass to meet the demands of the livestock industry requires significant infrastructure investments and technological advancements, and this source is still far from being competitive with conventional feed sources for widespread adoption.

ACKNOWLEDGEMENTS

This research has been supported by the ProFuture project (H2020 Grant Agreement n°862980) and by IRTA Consolidated Research Group 2021 SGR 00461 and CERCA (Generalitat de Catalunya).

REFERENCES

1. Zampiga, M.; Laghi, L.; Soglia, F.; Piscitelli, R.; Dayan, J.; Petracci, M.; Bonaldo, A.; Sirri, F. (2024) Partial substitution of soybean meal with microalgae meal (Arthrospira spp.–Spirulina) in grower and finisher diets for broiler chickens: implications on performance parameters, footpad dermatitis occurrence, breast meat quality traits, amino acid digestibility and plasma metabolomics profile. Poultry Science, 103(8), 103856.
2. Madeira, M. S.; Cardoso, C.; Lopes, P. A.; Coelho, D.; Afonso, C.; Bandarra, N. M.; Prates, J. A. (2017) Microalgae as feed ingredients for livestock production and meat quality: A review. Livestock science, 205, 111-121.