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## Nutritional value and antioxidant potential of silkworm pupae and soybean in broiler diets

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**Abstract:** Efforts to reduce dependence on soy-based feed ingredients have intensified the search for sustainable protein sources in poultry nutrition. Silkworm pupae, a byproduct of sericulture, represent a promising alternative because of their high nutritional value. This study compared whole-fat silkworm pupae with whole-fat soybean in terms of chemical composition, fatty acid profile, and antioxidant status as a preliminary assessment of their use in broiler diets. Silkworm pupae showed higher protein and fat contents, a more favorable omega-three-rich fatty acid profile, and greater water-soluble antioxidant capacity. Overall, these findings support the potential of silkworm pupae as a sustainable alternative feed ingredient.

### Introduction

The search for sustainable and cost-effective protein sources in poultry nutrition has increased interest in alternatives to soybean. Insect-derived ingredients are considered promising due to their high protein content, favorable lipid profile, and lower environmental footprint. Among them, silkworm pupae (*Bombyx mori*), a byproduct of sericulture, have attracted attention as a potential feed ingredient. In addition to being rich in protein and fat, they contain valuable fatty acids and bioactive compounds that may enhance the nutritional and functional quality of poultry diets. Therefore, this study compared whole-fat silkworm pupae and whole-fat soybean in terms of chemical composition, fatty acid profile, and antioxidant status.

### Materials and methods

Whole-fat silkworm pupae and whole-fat soybean were used as experimental materials. Six independent samples of each ingredient were analyzed after grinding and homogenization. Proximate composition was determined on a dry matter basis, including crude protein, ether extract, crude fiber, ash, and gross energy. Fatty acid composition was analyzed after preparation of fatty acid methyl esters and gas chromatographic determination, and results were expressed as individual fatty acids, grouped as saturated, monounsaturated, and polyunsaturated fractions, as well as omega-three and omega-six fatty acids. Antioxidant status was evaluated by measuring total antioxidant capacity, total phenolic content, and Trolox equivalent antioxidant capacity in water-soluble and liposoluble fractions.

### Results and discussions

As shown in Table 1, silkworm pupae contained higher crude protein, crude fat, and gross energy than soybean, whereas soybean had higher ash and crude fiber. According to Figure 1, silkworm pupae also exhibited a more favorable fatty acid profile, with higher palmitic, oleic, and especially  $\alpha$ -linolenic acid, leading to greater  $\omega$ 3 content and a markedly lower  $\omega$ 6/ $\omega$ 3 ratio, while soybean was richer in linoleic acid,  $\omega$ 6 fatty acids, and total PUFA. As presented in Table 3, silkworm pupae showed higher water-soluble antioxidant capacity, whereas the remaining antioxidant parameters did not differ between the two ingredients.

### Conclusions

Whole-fat *Bombyx mori* pupae showed higher protein, fat, and gross energy than soybean, together with a more favorable  $\omega$ 3-rich fatty acid profile and greater water-soluble antioxidant capacity. These findings support silkworm pupae as a sustainable alternative feed ingredient, warranting further in vivo evaluation in broiler nutrition.



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Table 1

Proximate Analysis	Units	Silkworm Pupae	Soybean
Crude Protein	%	53.5	39.2
Gross Energy	kcal/kg	6976.6	5567.4
Crude Fat	%	25.8	20.1
Ash	%	4.3	5.5
Crude Fibre	%	3.3	5.8

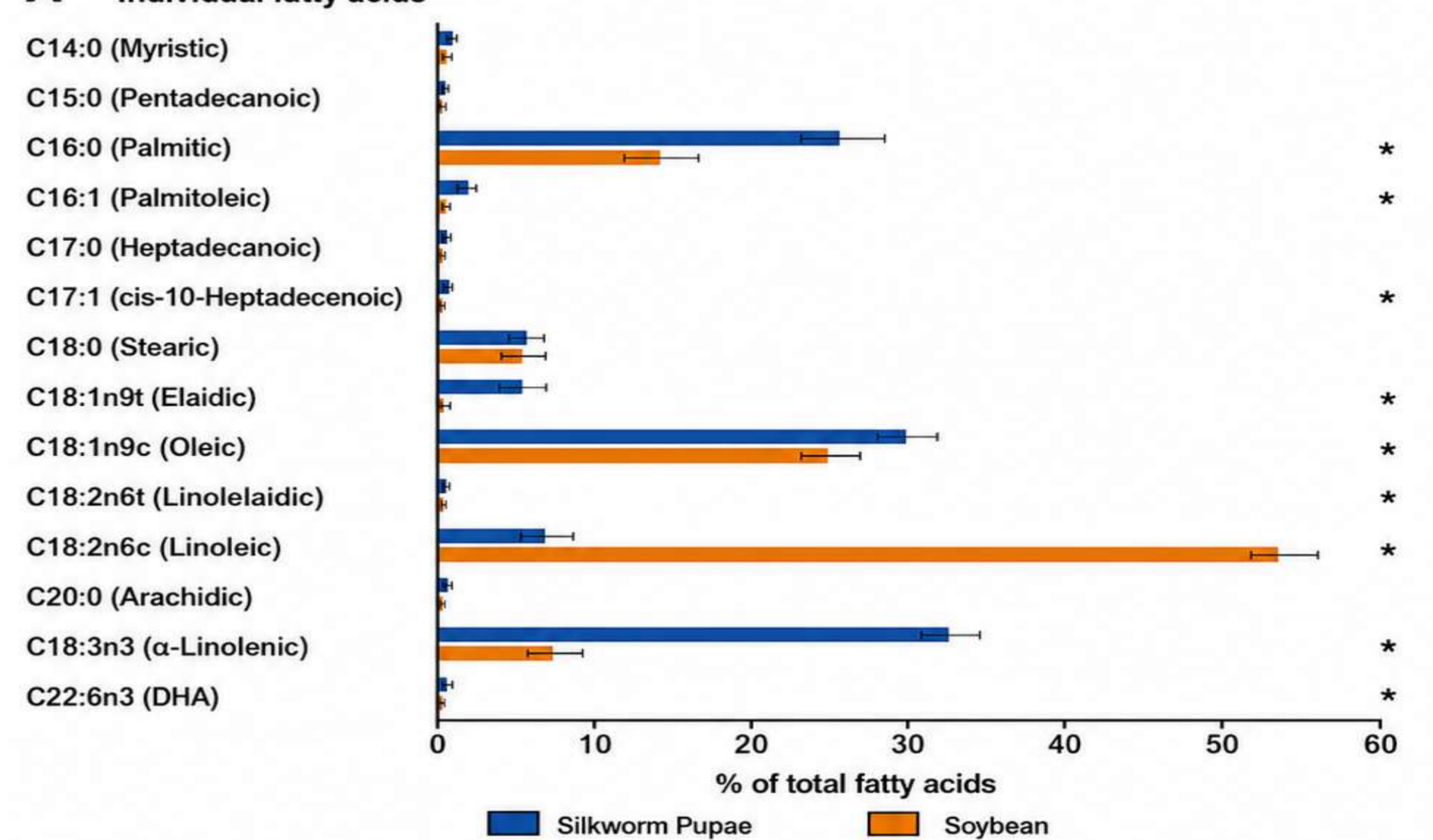
Table 2

Antioxidant parameter	Units	Silkworm Pupae	Soybean	P
TEAC <sub>lipo</sub>	mmol TE / 100 g sample	0.57±0.07	0.63±0.05	0.128
TEAC <sub>aq</sub>	mmol TE / 100 g sample	24.68±1.56	21.43±1.25	0.003
TAC	µg AAE / g DM	93.74±2.48	96.89±2.88	0.070
TPC	µg GAE / g DM	72.70±12.79	64.99±11.86	0.304

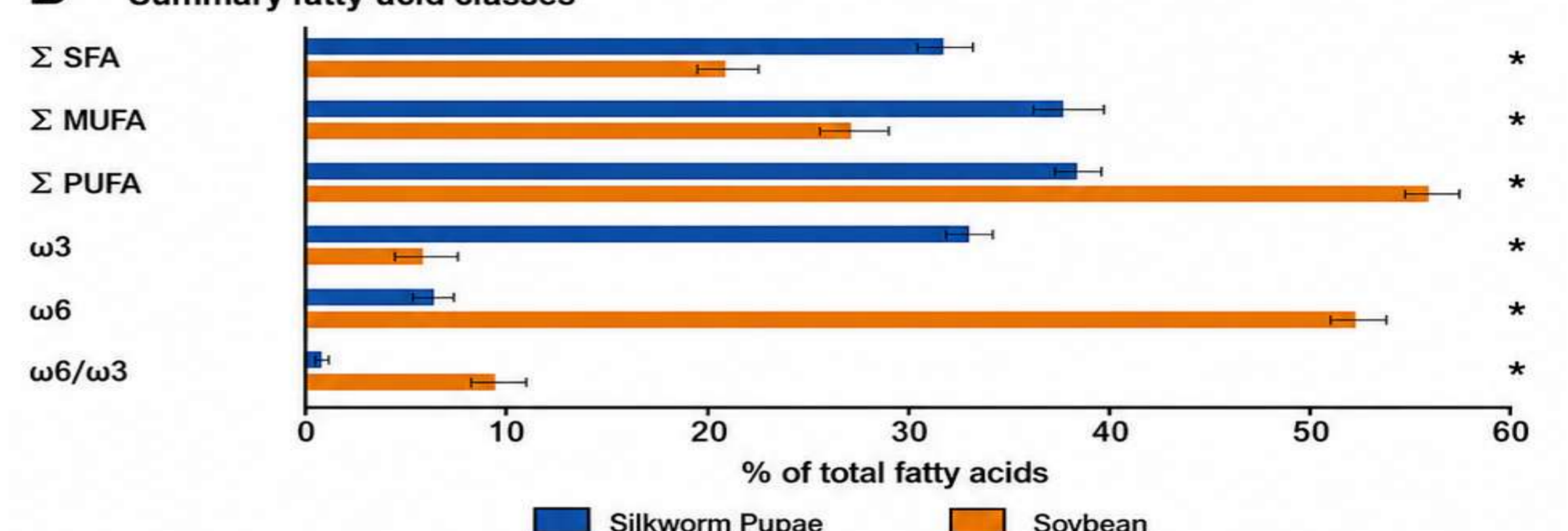
Figure 1

### Fatty acid profile of silkworm pupae and soybean (% of total fatty acids).

#### A Individual fatty acids



#### B Summary fatty-acid classes



\* Significant difference between silkworm pupae and soybean (P < 0.05).