



NUTRITIONAL QUALITY AND VALORIZATION OF SILKWORM PUPAE (BOMBYX MORI. L) IN POULTRY DIETS – REVIEW



Anca GHEORGHE¹, Mihaela HĂBEANU¹, Nicoleta A. LEFTER², Teodor MIHALCEA¹

¹Research Station for Sericulture Baneasa Bucharest, Romania

²National Research-Development Institute for Biology and Animal Nutrition Balotesti, Romania

CONTEXT

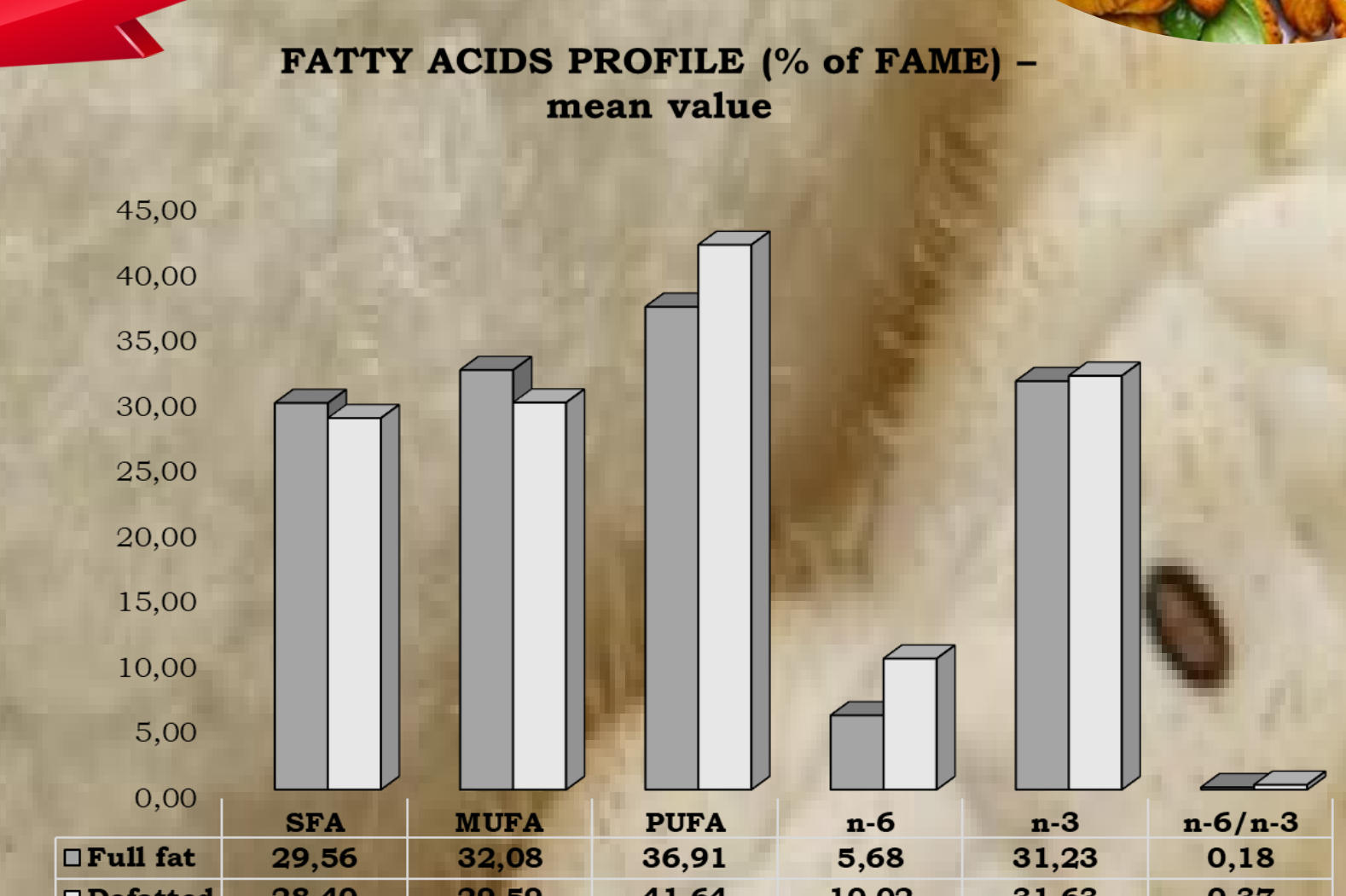
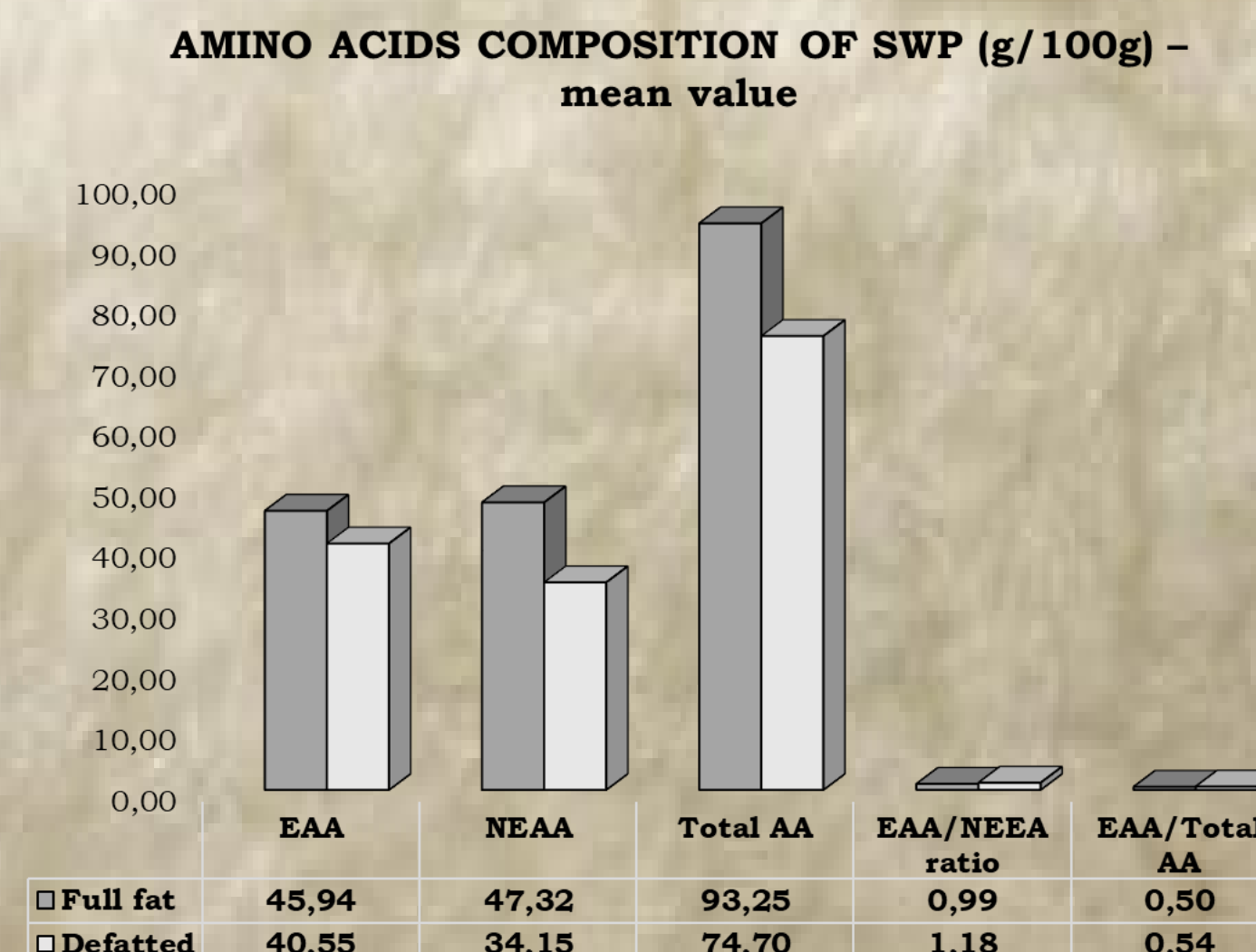
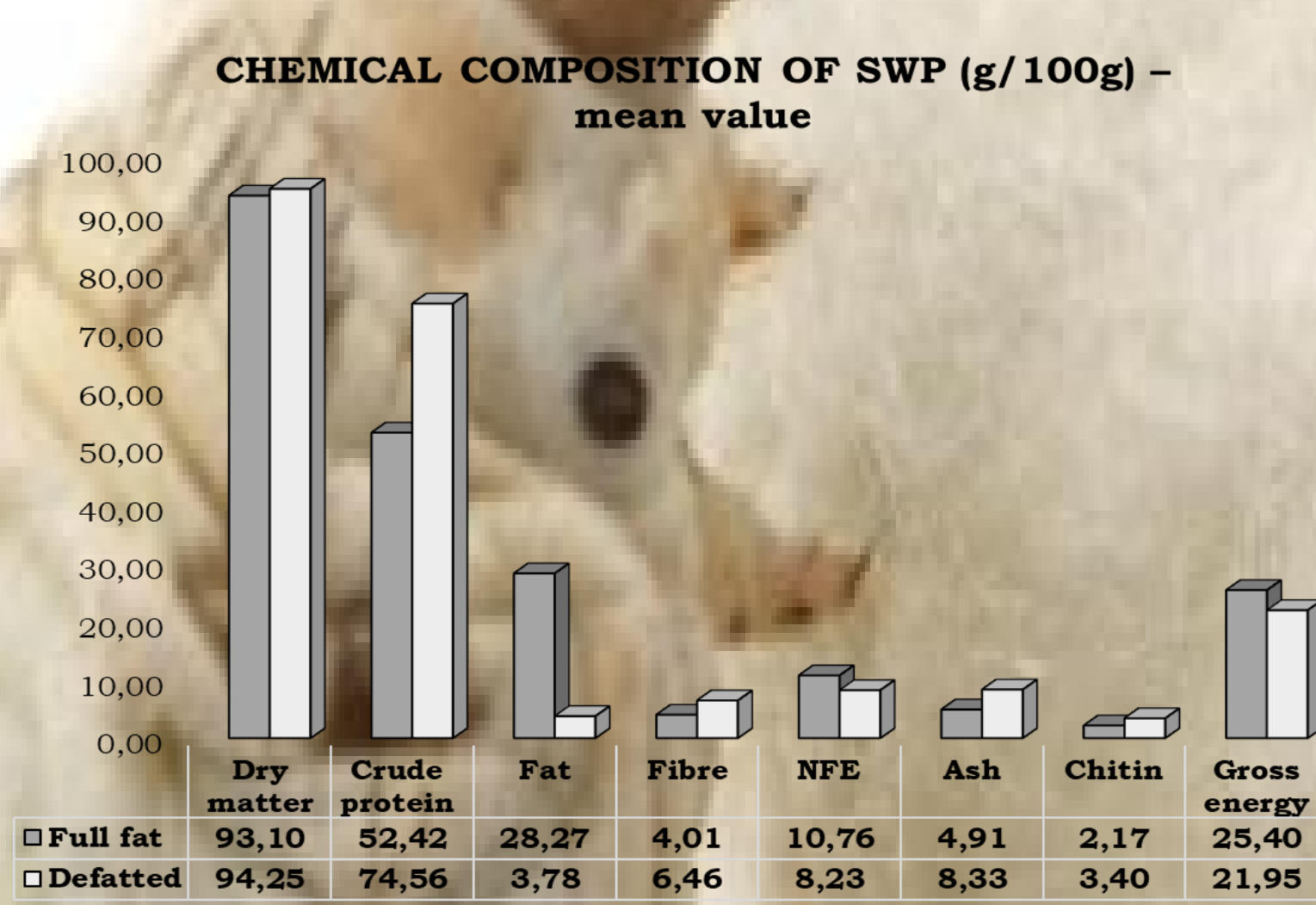
- ✓ The increase in global meat demand, on the one hand, and the development of the poultry industry, on the other hand, increase the request for conventional feed ingredients (soy grains and other oilseed sources), leading to higher costs and forward environmental pressure. Protein is the most expensive and limiting component in feed formulations, and the cost of conventional protein sources has increased considerably due to productivity factors and competition between plant-based human and animal feeds (Van Huis and Oonincx, 2017; Parisi et al. 2020).
- ✓ There is an increased interest in finding sustainable alternatives such as protein-rich insect species as innovative ingredients in animal feeds (Van Huis and Oonincx, 2017; Allegretti et al., 2018; Kim et al., 2019; Patel et al., 2019; Gravel and Doyen, 2020; Gorbunova and Zakharov, 2021; Lu et al., 2022).
- ✓ Sericulture industry produces a lot of by-products, including larvae, pupae and excreta (Bhavsar et al., 2020), and the economic potential of this sector depends on the ability to valorize them (Sharma et al., 2022; Hăbeanu et al., 2023a).
- ✓ Mulberry silkworm pupae (SWP), the main by-product of the silk industry, are considered a valuable alternative protein and fat source for feed (Saviane et al., 2021; Wu et al., 2021; Herman et al., 2022), supporting the circular production systems and preventing the discharge of potentially hazardous waste into the environment (Grzeškowiak and Lochyńska, 2021; Tassoni et al., 2022).

OBJECTIVE

This review highlighted:

- the nutritional value of SWPs as potential feed ingredients for poultry;
- effects of using SWP in poultry diets, focusing on productive performance, nutrient digestibility, health status and quality of poultry products.

RESULTS



EFFECTS OF USING SWP IN POULTRY DIETS (1)

References	Species	Breed	SWP type	Level of inclusion and/or substitution, %	Age/Period	Main results
Khatun et al., 2003	Chicken	Arbor Acres	FF	6% FM+0% SWP 4% FM+2% SWP 2% FM+4% SWP 0% FM+6% SWP	1-42 d	↑ growth rate with the ↑ in dietary SWP level. ↓ FI and ↑ FCR at 28 and 42 d. ↓ the total cost of production/ kg live broiler and ↑ profit/broiler ↑ in dietary SWP level.
Khatun et al., 2005	Chicken	Rhode Island Red (RIR)	FF	6 to 8% SWP, replacing protein concentrate	28-45 weeks	6% SWP ↑ profitability, growth and egg production performance of RIR. ↓ gradually the cost/kg of feed with ↑ the level of SWP in the diet.
Konwar et al., 2008	Chicken	Broiler	n/a	0–100% of FM, with or without enzyme	n/a	No adverse effect on replacing FM with SWP. SWP and enzymes boosted development and ↓ FI. 50% SWP substitution of FM and enzyme supplementation obtained the highest results.
Dutta et al., 2012	Chicken	RIR	FF	0 and 100% substitution of FM	3-56 d	50% replacement of FM with SWP ↑ marginal profit due to lower cost of SWP. a linear ↑ SWP level in poultry feed was corresponding to ↓ in cost/ unit of feed.
Jintasatporn, 2012	Chicken	Broiler	DF	0-20% SWP, replacing 0-100% of FM	21-42 d	10% SWP inclusion level had a little adverse effect on broiler growth but no negative effect on the percentage of muscle yield, sensory traits of breast meat and palatability. ↑ SWP inclusion level detrimentally affects FCR and muscle yield.
Rahmasari et al., 2015	Quail	-	FF	0, 25, 50, 75% substitution of FM	10 weeks	↓ FCR, ↑ egg production and did not affect the physical quality of quail eggs.
Ullah et al., 2017	Chicken	White Leghorn	FF	0, 25, 50, 100% substitution of SBM	52-58 weeks	No difference in layers performance (BW, FI, hen day production (%), egg weight, FCR), nutrient digestibility, blood profile and egg quality parameters. Up to 50% SBM substitution with SWP in laying hens diet is recommended to archive better results.

EFFECTS OF USING SWP IN POULTRY DIETS (2)

References	Species	Breed	SWP type	Level of inclusion and/or substitution, %	Age/Period	Main results
Ullah et al., 2018	Chicken	Broiler	FF	0, 2, 4, 6, 8% SWP, 0, 25, 50, 75, 100% substitution of SBM	1-28 d	No effect on broiler performance and carcass quality. ↓ gradually the cost/kg of feed with ↑ dietary inclusion level of SWP, indicating higher economic benefit. Up to 75% SBM substitution with SWP in the starter diet is recommended to archive better performance and dressing percentage without affecting meat sensory quality.
Khan et al., 2018	Chicken	Ross 308	DF	7.8% SWP	1-35 d	Improve BW and FCR with no difference in FI, mortality and dressing percentage, and sensory analysis of broiler breast meat compared to control.
Miah et al., 2020	Chicken	Rhode Island Red x Fayoumi crossbred	FF	7 and 14% SWP, 0, 25, 50% substitution of SBM and 100% of soybean oil	1-56 d	7% SWP dietary level achieves good growth performance, carcass traits and proximate composition of meat. 14% SWP dietary level favourably modifies the fatty acids profile of the chicken breast meat, decreasing the n-6/n-3 PUFAs ratio.
Rafiqullah et al., 2020	Chicken	White Leghorn	FF	0, 25, 50, 100% substitution of SBM	45-55 weeks	Substitution of SBM with SWP had no adverse effect on production performance, intestinal histomorphology and blood biochemical functions of liver and kidney.
Dalle Zotte et al., 2021	Quail	-	FF DF	12.5% SWP 12.5% SWP	16-33 d 33-46 d	↑ DM intake and excreta production. ↓ apparent digestibility of DM, OM CP, EE, starch and energy due to the presence of chitin and 1-DNJ. ↑ <i>Streptococcaceae</i> , <i>Rikenellaceae</i> and <i>Eubacteriaceae</i> families and taxa at the species level, such as <i>Lactobacillus delbrueckii</i> , <i>Aneurinibacillus thermoaerophilus</i> and <i>Bacillus thermoamylovorans</i> in excreta of quails fed FF than DF and control.
Pietras et al., 2021	Chicken	Ross 308	FF	17% SWP and 20% lupin	21-42 d	SWP and lupin can totally replace SBM in the grower diet for broilers with no adverse effect on production, slaughter performances and sensory quality of the meat.
Zsedely et al., 2023	Chicken	Ross 308	DF	0, 4% SWP (starter), 4% SWP (grower-finisher)	1-42 d	Comparable growth performance, carcass, and physicochemical meat quality traits. Based on the meat proximate analysis results, SWP use in the grower-finisher diet was the best option.

Abbreviations: SWP, silkworm pupae; FF, full-fat; DF, defatted; FM, fish meal; SBM, soybean meal; DM, dry matter; OM, organic matter; EE, ether extract; 1-DNJ, 1-Deoxyojirimycin; ↑ = increased; ↓ = decreased; BW, body weight; FI, feed intake; FCR, feed conversion ratio.

CONCLUSIONS

- SWPs are sericulture by-products with valuable nutritional value that can be considered cost-effective and sustainable alternative protein sources for poultry feed, especially in the current context of increasing demand for protein.
- The findings demonstrated that SWP could partially or replace conventional protein ingredients in poultry diets, maintaining appropriate performance, nutrient digestibility, health status and/or improving meat or egg qualities.

AN INSIGHT ON FATTY ACIDS PROFILE OF SILKWORM PUPAE (*BOMBYX MORI L.*) AND THEIR SOCIAL AND ENVIRONMENTAL IMPLICATION



Mihaela HĂBEANU¹, Anca GHEORGHE¹, Teodor MIHALCEA¹, Nicoleta A. LEFTER²

¹Research Station for Sericulture Baneasa Bucharest, Romania

²National Research-Development Institute for Biology and Animal Nutrition Balotesti, Romania

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INTRODUCTION

- ☞ Sericulture is a traditional occupation for rearing silkworms (SW), that associate art with the science and having deep roots in human history.
- ☞ By rearing SW, it is explored the potential to produce significant biomaterials and their application in cosmeceuticals, food additives, medical materials, tissue engineering, regenerative medicine.
- ☞ SW are recognized as environmental-less expensive and sustainable resources.
- ☞ One of the main by-products produced throughout the life are silkworm pupae (SWP), which are proposed to be used in human and animal nutrition, thus avoiding, and minimizing the negative impact on the environment.



OBJECTIVE

This review focused on *B. mori*, aiming to summarize the fatty acids composition of SWP and their importance that associated with other bioactive compounds could influence SWP value and diversify the ways of valorization and impact the environment and social life.

CHEMICAL COMPOSITION

Specification	%, DM	References
Protein	48-94.98	Herman et al. (2022), Wu et al. (2021), Lamberty et al. (2019) Sheikh et al. (2018)
Lipid	6.2-37.1	Herman et al. (2022), Wu et al. (2021) Feedpedia, Sheikh et al. (2018)
Fiber	2.5-5.8	Feedpedia, Sheikh et al. (2018)
Ash	5.8	Sheikh et al. (2018)
Chitin	3-4	Herman et al. (2022)
Gross Energy, (MJ/kg DM)	25.8	Lamberty et al. (2019)

FATTY ACIDS

Fatty Acids	% total FAME
Palmitic	21-28
Stearic	4.5-9.2
Oleic	26-38
Alpha-linolenic	17-38
Linoleic	3.8-8.6
Saturated	30.0-40.0
Unsaturated:	60-70
- Polyunsaturated	43.6
- Monounsaturated	27.7

IMPLICATIONS

Alpha-linolenic and linoleic FA, have been viewed as nutraceuticals and functional foods. Interest in n-3 FA began many years ago, but it is still quite active due to their therapeutic effect and view as preventive agents to reduce the risk of certain diseases. According to medical and scientific studies, the pharmacological functions of essential FAs include an improved of the insulin sensitivity, a decrease of blood pressure, decreasing thrombotic tendency, anti-inflammatory and antiarrhythmic effects, vascular endothelial functions, and increasing of the plaque stability.

CONCLUSION

Sericulture is not only about manufacturing silk, imperative being to explore and valorise the potential of this kind of insects to positive influence our health, to complete humans and animals' diets and for mitigating and control environmental pollutants.

11th International Conference AGRICULTURE & FOOD, 14-17 August 2023, Burgas, Bulgaria