Foods 2024 Conference
The 5th International Electronic Conference on Foods
28–30 October 2024 | Online
MDPI

Transforming Vegetable Waste: Insect Flour Quality through *Tenebrio molitor* Larvae Supplementation

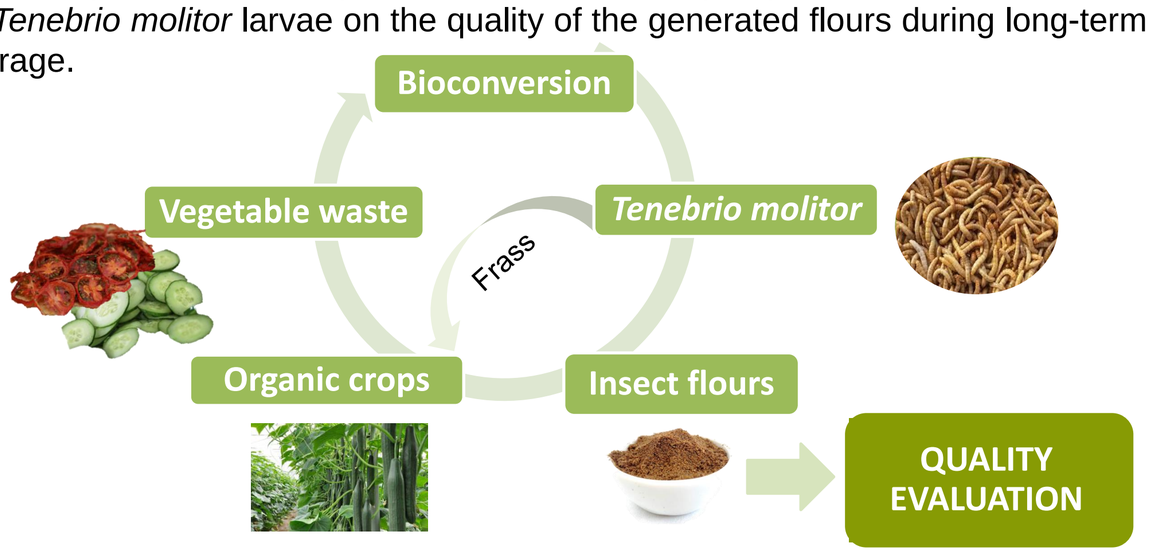
Gloria López-Gámez[1]*, Raquel del Pino-García[1]*, Andrea Justicia-Rueda[1], María Asunción López-Bascón[1], Vito Verardo[1,2,3]

1 Centro de Investigación y Desarrollo del Alimento Funcional (CIDAF), Avda. Conocimiento, 37, 18016, Granada, Spain.
2 Institute of Nutrition and Food Technology Jose Mataix, Biomedical Research Center, University of Granada, Avda. Conocimiento s/n, 18100, Granada, Spain.
3 Department of Nutrition of Food Science, Campus of Cartuja, University of Granada, 18071, Granada, Spain.
*glopez@cidaf.es; rdpinogarcia@cidaf.es

INTRODUCTION & AIM

Insect farming presents a viable solution to transform vegetable waste generated by the food industry into valuable products such as insect flours. Vegetable waste is rich in bioactive compounds and essential nutrients, which can potentially enhance the quality of insect flours.

This study aims to investigate the impact of adding vegetable waste to the diets of *Tenebrio molitor* larvae on the quality of the generated flours during long-term storage.



METHODOLOGY

DIET

- ✓ Wheat bran:waste vegetables (1:1)
- ✓ Supplementation for 6 weeks

INFRARED DRYING

- ✓ 68 °C
- ✓ 4 hours

FLOUR STORAGE

- ✓ Room temperature
- ✓ Darkness
- ✓ 12 months

QUALITY ATTRIBUTES EVALUATION

- Colorimetric evaluation of CIElab parameters
- Evaluation of lipid oxidation by the TBARS method
- Evaluation of % moisture
- Evaluation of microbiological load

MONTHS SAMPLING

M 0 → M 1 → M 2 → M 3 → M 6 → M 12

RESULTS & DISCUSSION

Colorimetric evaluation

Flours from larvae supplemented with tomato or cucumber waste showed higher L* and b* values compared to those fed only wheat bran (Table 1), likely due to changes in fatty acids composition and carotenoid intake. The lower a* values in supplemented flours may result from browning reactions during drying. During storage, L*, a* and b*, values decreased, especially in W flours. These color changes are consistent with the higher unsaturated fat content (data not shown) in flours from vegetable waste-fed larvae, which promotes oxidation and darker color development.

Table 1. Colorimetric evaluation of insect flours during 12 months of storage at room temperature.

Flour	(C+W) C						(C+W) E						(T+W) C						(T+W) E						W					
	M0	M1	M2	M3	M6	M12	M0	M1	M2	M3	M6	M12	M0	M1	M2	M3	M6	M12	M0	M1	M2	M3	M6	M12	M0	M1	M2	M3	M6	M12
a* (red/green color)	20	14	11	10	12	8	22	12	11	10	11	9	24	14	11	12	19	8	23	15	13	12	11	9	26	16	14	12	10	8
b* (yellow/blue color)	20	19	19	18	18	15	20	19	19	17	17	15	19	19	18	17	18	15	20	19	19	18	18	15	15	17	17	14	14	11
L* (luminosity/clarity)	38	37	37	37	36	37	38	37	37	36	36	36	38	37	37	36	36	36	38	37	37	37	37	35	37	36	35	34	34	33

***(C+W) C**: Conventional cucumber waste; **(C+W) E**: Ecological cucumber waste; **(T+W) C**: Conventional tomato waste; **(T+W) E**: Ecological tomato waste; **W**: Wheat bran (control)*

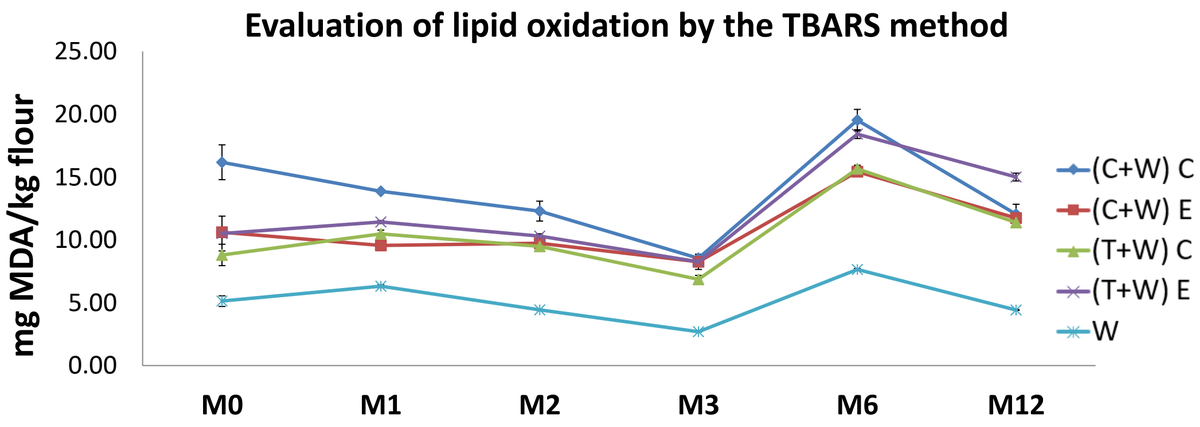


Figure 1. Lipid oxidation of insect flours during 12 months of storage at room temperature. **(C+W) C**: Conventional cucumber waste; **(C+W) E**: *Ecological* cucumber waste; **(T+W) C**: Conventional tomato waste; **(T+W) E**: *Ecological* tomato waste; **W**: Wheat bran (control)

Flours from larvae supplemented with cucumber had the highest lipid oxidation, while W flour showed the lowest one. The increased oxidation in supplemented flours is likely due to their higher polyunsaturated fatty acid content (data not shown). Over 3 months, these differences persisted, with supplemented flours showing up to 200% more oxidation than W flour. After 12 months, however, (T+W) E flours exhibited the highest lipid peroxidation, likely due to antioxidant degradation and changes in fatty acid composition during storage.

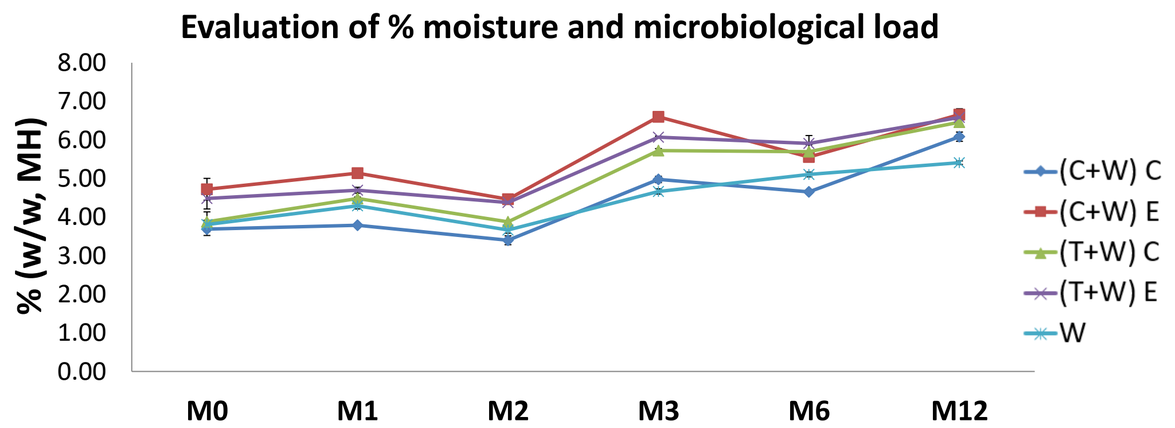


Figure 2. Moisture (%) of insect flours during 12 months of storage at room temperature. **(C+W) C**: Conventional cucumber waste; **(C+W) E**: *Ecological* cucumber waste; **(T+W) C**: Conventional tomato waste; **(T+W) E**: *Ecological* tomato waste; **W**: Wheat bran (control)

During storage, moisture content remained below 5% until the 3rd month. After that, the moisture of flours from larvae supplemented with vegetable waste reached 5.7% - 6.6%, which was maintained until the end of the 12-month stability study, whereas W flour had the lowest moisture (Figure 2). To prevent microbial growth, it should ideally remain below 5-7%, and these results are within that range, aligning with the microbiological findings. In the flours, all the analysed pathogenic microorganisms (*Salmonella* sp., *E. coli*, *L. monocytogenes*) were not detected.

CONCLUSION

The use of tomato and cucumber wastes as supplements for *T. molitor* diet is a sustainable strategy to revalorize vegetable waste. The flours produced maintain acceptable quality attributes for at least 3 months of storage at room temperature. Therefore, they could be used as ingredients for animal feed.

ACKNOWLEDGEMENTS

This research was funded by Junta de Andalucía and the European Union (FEADER), grant number GOPG-GR-20-0004 (GO ECOINSECT). G.L.G. postdoctoral contract belongs to Juan de la Cierva Formación-2021 (FJC2021-047564-I) funded by MCIN/AEI/10.13039/501100011033 and European Union "NextGenerationEU/PRTR". M.A.L.B. is grateful to "Consejería de Transforma-ción Económica, Industria, Conocimiento y Universidades de la Junta de Andalucía" for her post-doctoral contract (POSTDOC_21_00031).