The Power of Insect-Based Nutrition through the Example of Bread

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BACKGROUND

Edible insects are becoming a valuable source of protein, unsaturated fatty acids, vitamins, and minerals. Their addition to food, including bread, enriches its nutritional value andcontributes to sustainable development.

OBJECTIVE

The aim of this study was to evaluate the effect of partially replacing wheat flour with powder from *Tenebrio molitorlarvae* and adult *Acheta domesticus* (5–30%) on techno-functional flour properties, sensory acceptance of insect-enriched bread, and its nutritional value.

METHODS

Six flour blends were prepared by substituting wheat flour with insect flour (*Acheta domesticus* and *Tenebrio molitor*) at levels of 5%, 10%, 15%, 20%, 25%, and 30% (w/w).

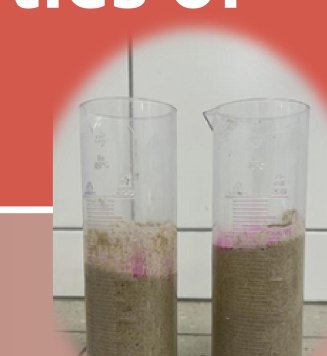
Particlesizedistribution of flourblends

The CIE Lab system

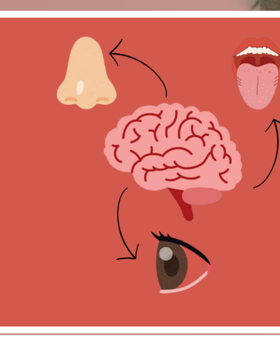
Measurement of bread hardness using a penetrometer

Diet 6D software

Evaluation of the fermentation properties of flour blends

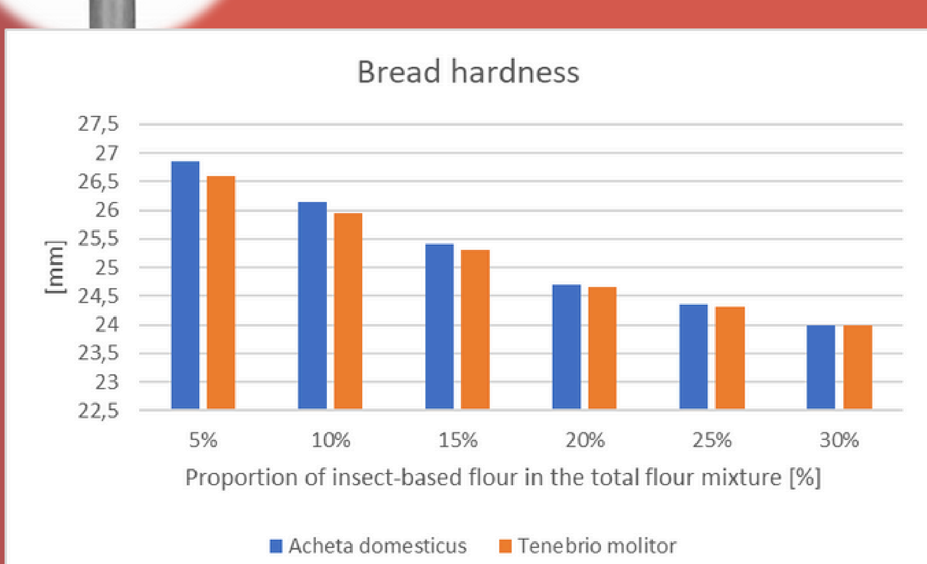


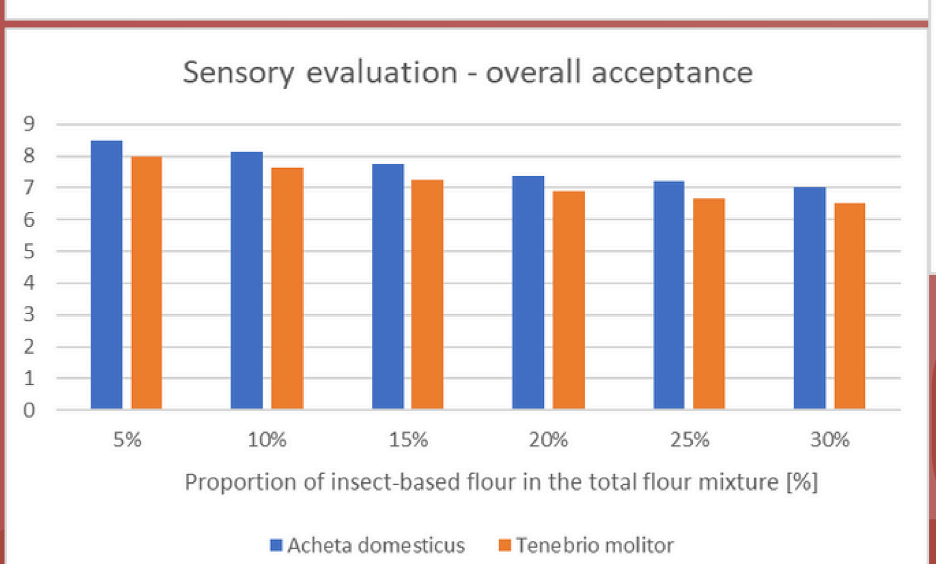
Sensory evaluation

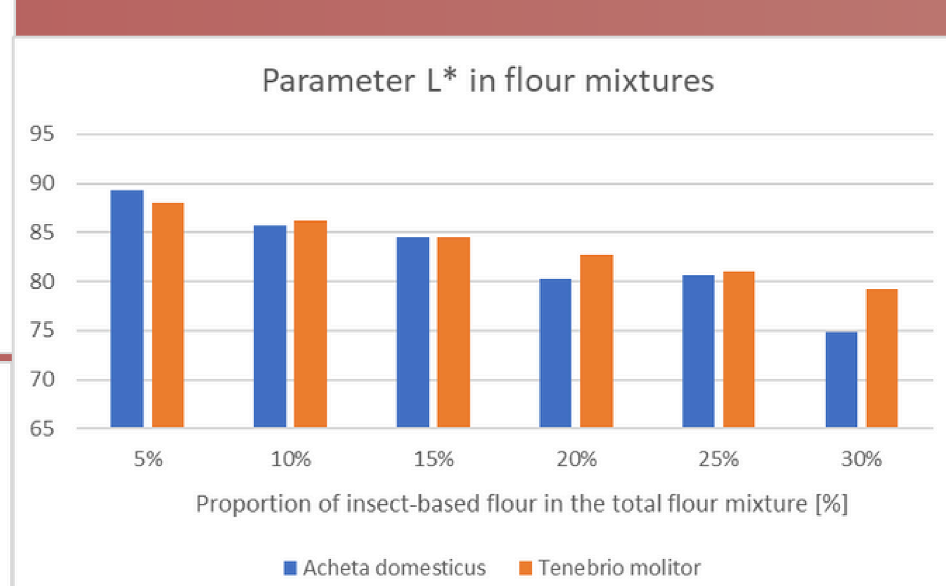


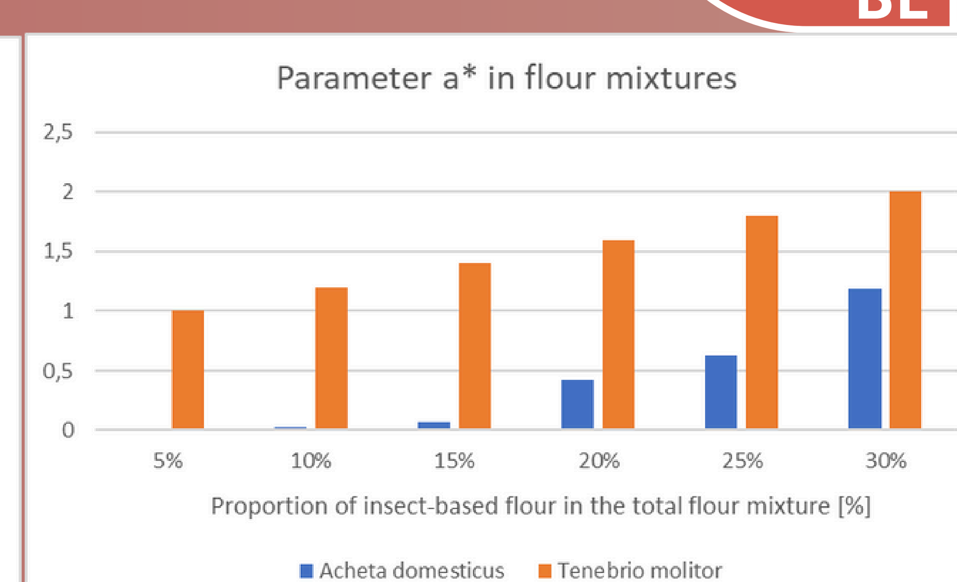
Baking loss (BL), where:
DM – dough mass,
BM – baked bread mass
BL [%]=((DM-BM) ∗ 100%)/DM

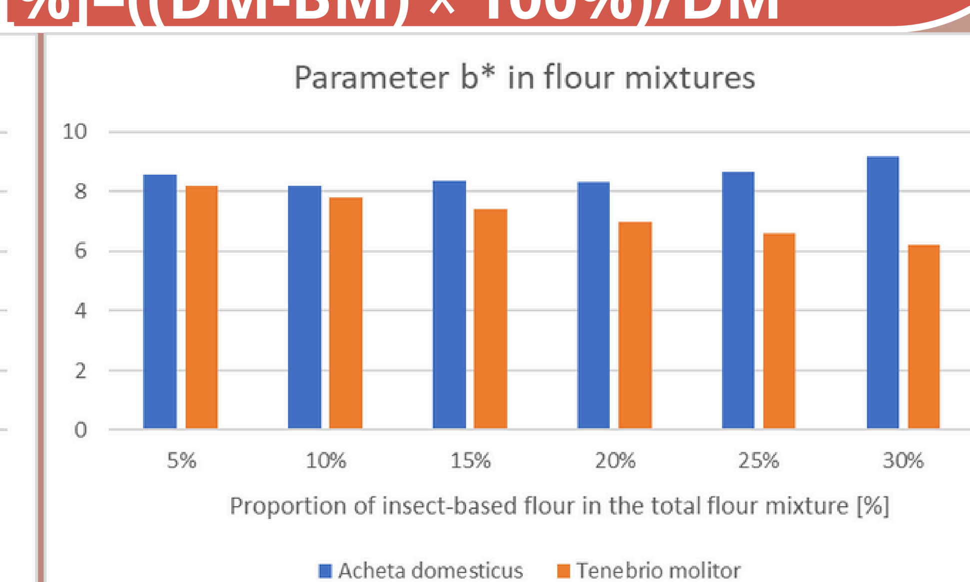
RESULTS











Gradual increase in the proportion of insect flour in wheat-based blends, particularly above the 15% level, leads to a noticeable deterioration in the uniformity of particle size distribution, manifested by an increase in coarse fractions (>500 µm) and a reduction in the content of fine particles.

Cricket flour is characterized by a higher degree of fineness compared to mealworm flour, which may be attributed to anatomical differences between the insects, including a thinner exoskeleton and lower chitin content in crickets.

Flour blends enriched with *Acheta domesticus* exhibited higher fermentation activity than those containing Tenebrio molitor. After 60 minutes of fermentation, the dough volume in the cricket-enriched samples reached 145 cm³, while the mealworm-enriched dough reached 130 cm³. By 75 minutes, the volumes increased to 180 cm³ for the cricket blend and 152 cm³ for the mealworm blend. Even after 85 minutes, the cricket-based dough maintained a higher volume (175 cm³) than the mealworm-based dough (140 cm³), indicating more favorable fermentation behavior.

Adding *Acheta domesticus* and *Tenebrio molitor* flour to wheat flour significantly improves the nutritional value of bread, particularly in terms of protein, fat, energy, and selected minerals. Enriching bread with 30% cricket flour increased the protein content from 8.0 to 22.6 g/100 g, fat from 1.6 to 8.0 g, and energy to 327 kcal. In the case of mealworm flour, the values reached 22.4 g of protein, 9.1 g of fat, and 325 kcal. Iron content increased more than fourfold, from 1.0 mg to 4.1 mg, with the addition of *Acheta domesticus*, and to 3.45 mg with *Tenebrio molitor.* These findings confirm that both insect-based ingredients significantly enhance the nutritional profile of bread, although the enrichment pattern depends on the insect species used.

Increasing the proportion of insect flour (from cricket and mealworm) in the 5–30% range led to a gradual reduction in baking loss (from 14.9% to 13.5%). No significant differences were observed between the results obtained for the two types of flour.

CONCLUSION

The study confirmed that flours derived from *Acheta domesticus* and *Tenebrio molitor* can enhance bread's nutritional and technological properties. Notably, cricket flour (*Acheta domesticus*) demonstrated particularly favorable effects, indicating its greater applicability in the production of functional bread. This is attributed to its higher protein content, superior fermentation performance, and better consumer acceptance, as evidenced by sensory evaluations. Furthermore, incorporating insect flour contributes to advancing sustainable solutions within the food industry, offering an alternative protein source with a lower environmental footprint than traditional livestock