Comparative study of the impact of the cooking on meat analogues enriched with fresh or dried microbial biomass (*Arthrospira platensis*)

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Context of the study

Meat contains a large quantity of proteins with a high biological value (complete amino acid profile and good digestibility). Meat consumption is intended to decrease for ecological reasons. Alternative proteins sources, like plant-based proteins (including meat analogues), exist and need to gain more shares in the human diet. Nevertheless, the digestibility, the organoleptic properties and the amino acid profile remain not ideal. Foodstuffs made from microbial biomass like spirulina (*Arthrospira platensis*) are a promising solution to substitute meat from a nutritional point of view. Foodstuffs enrichment with a low quantity of dried spirulina is nowadays a well-known practice according to the scientific literature. Enrichment with fresh spirulina instead of dried biomass has already shown better results in terms of organoleptic and nutritional properties. However, it is still necessary to study product formulation and cooking processes in order to keep the nutritional assets of fresh biomass.

The strategy

The aim was to compare **2 formulations** which vary only according to the physical form of the spirulina.

The foodstuff model chosen was a “burger”. This product, classically made from chopped meat, is widely consumed and already exists as meat analogue (with plant-based proteins). On top a large amount of biomass can be incorporated in this preparation.

2 meat analogues recipes were formulated (4 repetitions), one with **dried** spirulina biomass (air dried at 10% moisture) and one with **fresh** spirulina biomass (77% moisture) originating from the supplier Etika Spirulina in France. Water, oat flakes, wheat flour and textured wheat protein were added to have a patty suitable for burgers shaping and have similar nutritional characteristics than plant-based burgers. Unlike usual plant-based burgers, only a small quantity of textured proteins was incorporated, in order to minimize the impact of this highly functional ingredient but still have an adequate texture.

Preparation procedure to make the burgers:

(1) Mixing of the ingredients with a robot and 20 minutes resting.
(2) Shaping of the burgers (manually).
(3) Baking : 14 minutes at 180°C (Rational oven).

The preparation and the cooking conditions remained the same across all the formulations. To assess the effect of cooking on both formulations, 3 parameters have been measured :

(1) The **moisture preservation** was assessed by measuring the dry matter and the weight of the raw and baked product. [Tab 2]
(2) The **texture** of the baked product was determined via a Texture Profile Analysis (TPA). [Fig 4]
(3) The **color** of the baked product was assessed with a colorimeter (LAB method). [Tab 2]

Fig 1 : Dried spirulina (left) and fresh spirulina (right).

Fig 2 : Burger patties enriched with fresh spirulina (left) and dried spirulina (right).

Ingredients	With fresh spirulina	With dried spirulina
Fresh spirulina biomass	60	0
Air dried biomass	0	15
Textured Wheat Protein	5	5
Wheat flour	10	10
Oat flakes	25	25
Water	0	45
Moisture	47,8	47,95
Dry matter	52,2	52,05
Protein content	17,8	17,76

Tab 1 : Theoretical composition of 2 tested formulations (% w/w).

Results

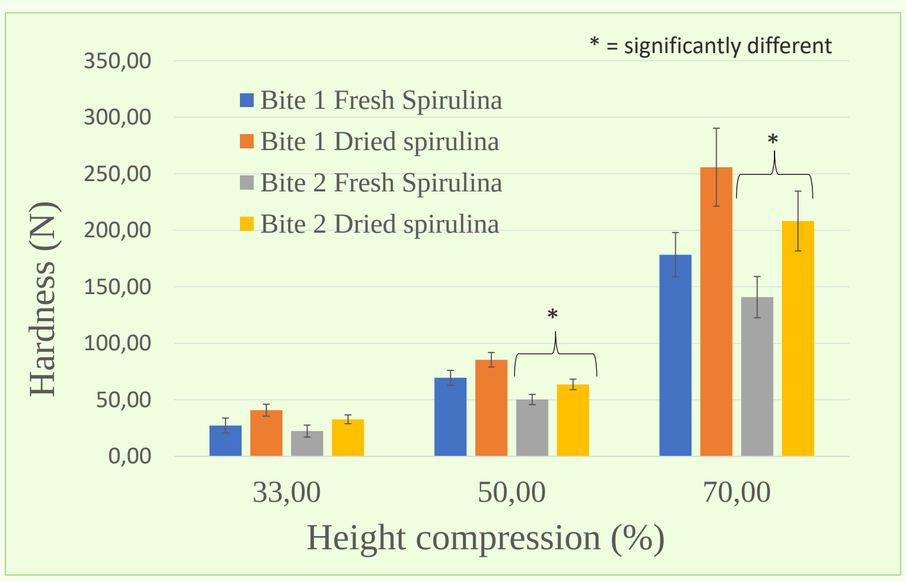

Fig 4: Burger hardness according to height compression during a TPA.

	With <u>fresh</u> spirulina	With <u>dried</u> spirulina
Weight raw (g)	65,77 ± 0,58	66,55 ± 1,01
Weight baked (g)	60,68 ± 0,63	61,78 ± 1,08
DM raw (%)	51,87	50,39
Moisture raw (%)	48,13	49,61
Moisture baked (%)	42,47 ± 1,78	44,38 ± 0,93
Moisture retention (%)	81,41 ± 0,58	83,02 ± 1,65
Baking yield (%)	92,26 ± 0,63	92,82 ± 0,22
L (lightness)	$18,09^{a}$ ± 0,12	$19,15^{b}$ ± 0,04
a (redness)	$-1,06^{a}$ ± 0,06	$-1,38^{b}$ ± 0,11
b (yellowness)	$1,06^{a}$ ± 0,03	$0,77^{b}$ ± 0,05

Tab 2 : Measured parameters of the 2 tested formulations
Different superscripts in the same row indicate significantly different values ($p < 0.05$)

Fig 3 : Burger enriched in fresh spirulina (left) and dried spirulina (right) baked 14 minutes at 180°C.

Discussion

- Regarding the moisture retention, no significant differences between formulations with dried or fresh biomass were observed. The effect of the textured wheat protein on the water preservation is probably high (masking the effect of the biomass form).
- The bite 2 hardness is lower with fresh spirulina (50% and 70% height compression) which could mean an easier mastication.
- A significant color difference exists between both tested formulations.

Perspectives and next steps

- Try formulation with non lysed fresh cells and reassess the moisture preservation.
- Use another type of microbial biomass (like purple bacteria).
- Test other formulations (on going).
- Compare different cooking conditions (to have a drying kinetic curve).
- Assess other types of dried biomass (spray dried and freeze dried).
- Compare obtained texture results with meat and plant-based burgers.
- Assess sensory differences (organic volatile compounds) could be considered in the future to detect off-notes and determine the maximum enrichment possible with dried biomass.

References

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