Fermentation of pea and soy protein with *Lactilactobacillus plantarum* improves flavor of plant-based burger patties.

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I. INTRODUCTION

First time buyers of Plant Based Meat Alternatives (PBMA) have recently been found to decline over a 2-year period [1], which is in line with a general stagnation observed in global sales of PBMA products. There can be many reasons for consumers not buying or repeat buying PBMA products, e.g. taste issues, cost price, ultra-processed, too many ingredients or quality aspects like texture and appearance. Flaws in taste and flavor of PBMA products are listed as main reason for not buying or rebuying by approx. 50% of US consumers [2].
The aim is to investigate if fermentation of soy or pea texturized protein with *L. plantarum* (MCX-2401) before preparation of PBMA burgers improves flavor and modifies volatiles detected.

II. MATERIALS AND METHODS

Samples with fermented soy or pea texturized protein are prepared and two controls with non-fermented plant proteins are used as references. Fermentation of texturized protein is carried by adding culture *L. plantarum* into water followed by mixing of culture suspension into dry texturized proteins (2.5:1 ratio) targeting an inoculation level of 4×10^6 cfu/g. The hydrated texturized proteins are incubated at 24°C or 30°C and then cooled to 5°C when pH reaches 5.5-5.6 in the fermented protein. Dough for burgers is made from water, mix of (fermented) texturized protein and protein isolate, while the fat part is vegetable oil and coconut fat. Minor components added are citrus fiber, lactate, tomato puree, methylcellulose, red beet color, spices, salt, and emulsifier. Preparation is by pre-grinding (6/3 mm) of fermented/hydrated texturized protein, which is mixed with dry ingredients suspended in remaining water, and frozen pre-grinding (6/3 mm) coconut fat/oils, while keeping temperature at 0°C. Burger patties are shaped each weighing 113 g.
In trial 1 a descriptive sensory test with 14 assessors is conducted using 13 pre-defined descriptors with Rate-All-That-Applies (RATA) to evaluate 4 fried plant-based burgers patties. In trial 2 semi-quantitative GC-MS headspace analysis of volatiles is performed on 3 soy-based burgers. Texturized protein is analyzed for Lactic acid bacteria (LAB) by plating on MRS agar. Final pH value is measured in plant burgers for 4 samples with or without fermentation of 2 texturized plant protein types.

III. RESULTS AND DISCUSSION

The fermentation step resulted in an increase in LAB concentration of more than 2 log cfu/g compared to initial inoculation level at 4×10^6 cfu/g. This also brings a drop in pH which impacted final pH value of the dough, where soy control has pH 6.6 while dough with fermented texturized soy protein has pH 5.5. For pea protein samples the respective pH values of control and pre-fermented samples are at 6.0 and 5.6, respectively.
From the descriptive sensory data submitted to multivariate analysis in Fig 1, samples with fermented texturized pea or soy protein are evaluated quite similar compared to the two non-fermented control samples. Also, the average scores for descriptors show that umami and meaty are rated significantly higher in fermented samples compared to controls. In contrast, for beany attribute the control samples both receive significant higher scores compared to both pre-fermented soy and fermented pea protein samples.

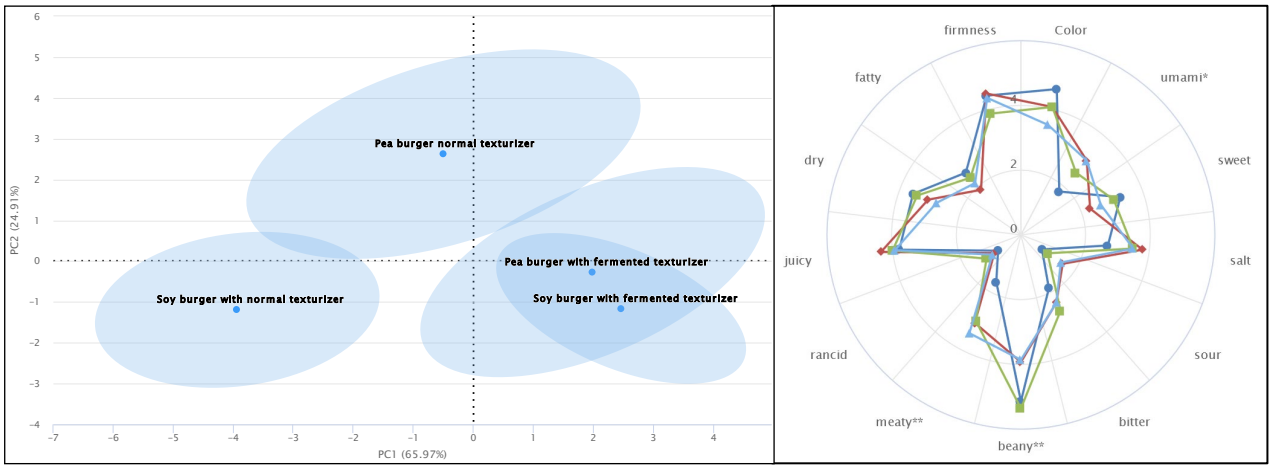

Figure 1. Sensory evaluation of fried plant-based burgers in trial 1 showing scores plot (a) from principal component analysis and spider plot (b) with average scores for 13 descriptors in fermented soy (-◆-), fermented pea (-▲-), control soy (-●-) and control pea (-■-). Descriptors marked with * or ** indicate statistically significant difference on $p<0.05$ or $p<0.01$ confidence level, respectively.

In Fig 2 lipid-derived carbonyls, pentanal, hexanal and heptanal associated with beany flavor notes, are reduced to 1/3 on average compared to amount in non-fermented texturized soy protein control.

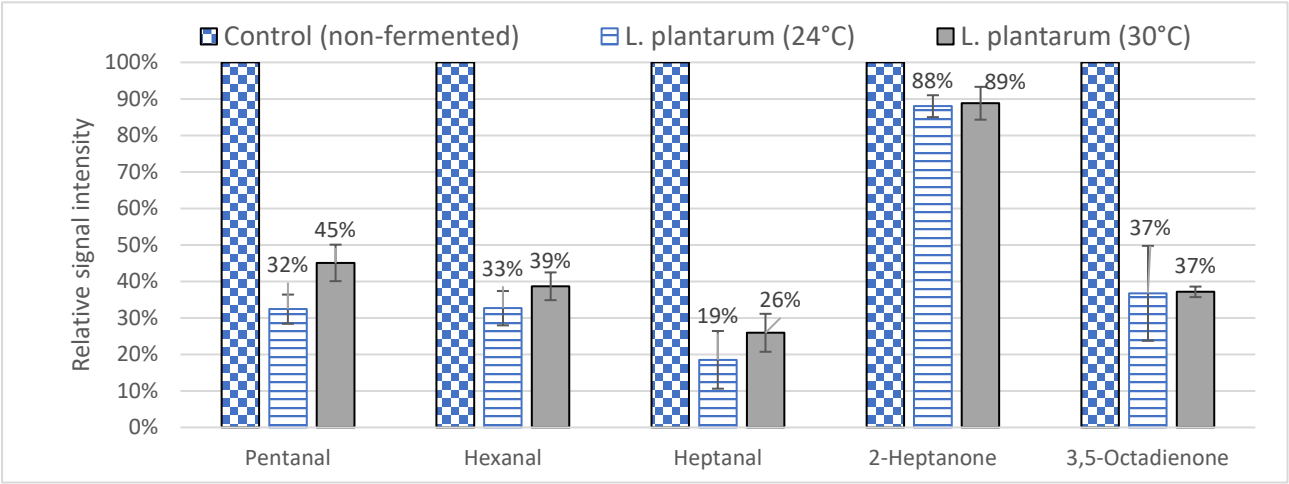

Figure 2. Analysis of selected volatiles, carbonyls and ketones, in trial 2 on fried soy-based burger patties. Signal intensity for non-fermented control is set as 100% and reduction in signal intensities for fermented samples shown as percentage.

IV. CONCLUSION

Fermentation of texturized soy or pea protein used in plant-based burgers can significantly improve taste and flavor by increasing meaty and umami ratings, while unpleasant beany note is reduced. Thus, fermentation of plant-based proteins is potentially a natural and traditional solution to address before-mentioned challenges regarding poor taste and flavor in PBMA products.

A substantial reduction in volatiles like pentanal, hexanal and heptanal due to fermentation is most likely accountable for observed decline in beany and corresponding increase in meaty and umami ratings.

V. REFERENCES

1. Neuhofer, Z.T., Lusk, J.L. (2022) Most plant-based meat alternative buyers also buy meat: An analysis of household demographics, habit formation, and buying behavior among meat alternative buyers. Nature Scientific Reports **12**, 13062
2. Anonymous (2023). State of the Industry Report. Plant-based meat, seafood, eggs, and dairy. The Good Food Institute US.