26th National Symposium for Applied Biological Sciences
8 July 2022, Antwerp, Belgium

Advances on physical treatments for soy allergens reduction

Andreea Diana KEREZSI*, Nicolas JACQUET and Christophe BLECKER

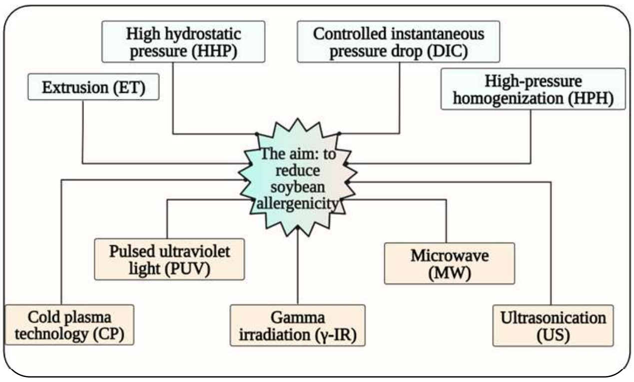
*Corresponding author: adkerezsi@uliege.be, andreeadianakrerezsi@gmail.com

Gembloux Agro-Bio Tech, Department of Food Science and Formulation, University of Liège, Gembloux, Belgium

INTRODUCTION

Food allergies represent one of the most rapidly increasing and significant human challenges connected with global health. Soybean has high protein and fat quality, but it is also responsible for allergenicity in humans, taking part from the list of "the big 8" allergens including milk, eggs, fish, crustacean shellfish, tree nuts, peanuts, wheat, and soy. Literature has shown that many common technologies could reduce allergenicity, such as thermal (dry heat -roasting and moist heat -autoclaving and boiling), enzymatic, and fermentation treatments [1]. These treatments require necessary amounts of energy and water, which can lead to high costs, limit the process's sustainability, and decrease food quality (color, smell, flavor, and texture) [2]. In this way, using physical processes could be a more durable solution in the current context of our society. New potential approaches for reducing soybean allergenicity are presented, divided into two categories. The first is related to pressure techniques, such as extrusion (ET), high hydrostatic pressure (HHP), high-pressure homogenization (HPH), and controlled instantaneous pressure drop (DIC). The second is related to waves: gamma irradiation (γ-IR), pulsed ultraviolet light (PUV), cold plasma (CP), microwave (MW), and ultrasonication (US).

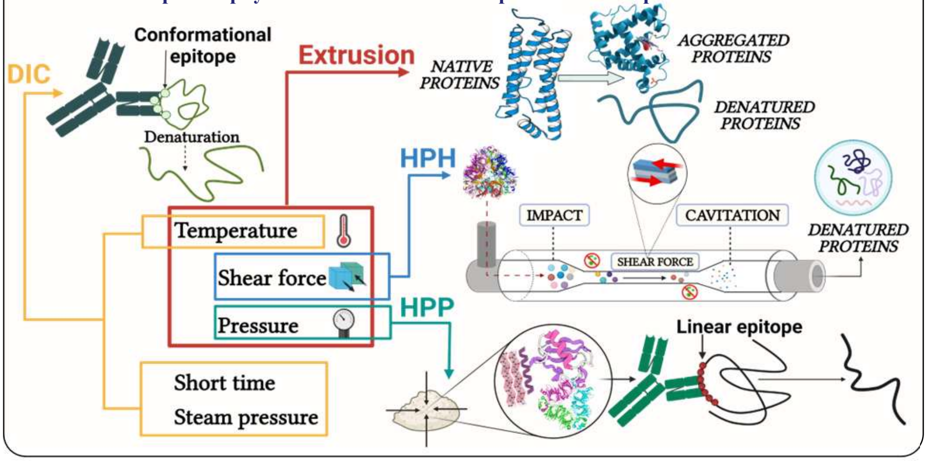
THE AIM OF THE STUDY



The techniques presented have the same common goal: lowering soybean allergenicity of the products with an impact on protein structure (affecting the secondary, tertiary, or quaternary structure).

METHODS AND RESULTS

The impact of physical treatments based on pressure on the protein structure



METHODS AND RESULTS

Table 1. The advantages and limitations of the physical treatments

Treatment	Advantages	Limitations
ET	-Good reduction of allergenicity (>70%) -Continuous process, high productivity, and low cost	-Temperature >200°C affects the nutritional quality of the product [3]
HHP	-Preservation of food properties -Minimal thermal exposure and reduced processing time -Environmentally friendly process	-Moderate (about 50%) reduction of allergenicity -Discontinuous process and high cost of pressure vessel (0.5 to 4 million €) [4]
HPH	-Low-temperature and continuous process -Preservation of the protein nutritional values	-Weak reduction (< 30%) of allergenicity -High cost of maintenance [5]
DIC	-Good reduction of soy allergenicity (>70%) at a pressure higher than 0.6 MPa -Higher sensory properties and quick processing time	-High cost of the technology -The early state of use at the industrial level [6]
γ-IR	-Excellent reduction (>90%) at a higher dose (100 kGy) -Successful with different products -Inactivation of microorganism	-Weak reduction (<30%) of allergenicity at a low dose (25 kGy) -Long exposure to radiation can be harmful to industry workers -Limitation of legislation (maximum dose allowed for food is 10 kGy) [7]
PUV	-Excellent reduction of allergenicity (>90%) -Continuous and non-heat treatment -Few impact on flavor, color, aroma and environment	-Very high investment cost (300000-800000 €) -Long exposure to the radiation can be harmful to the industry workers [7]
CP	-Excellent reduction of allergenicity (>90%) -Required few amounts of energy and short treatment time	-Very recent technology, which required up-scaling towards industrial scale (low productivity) -Complexity (vacuum needed) and cost of the equipment [8]
MW	-Shorter time of equipment starting and duration of the process	-Weak reduction (<30%) of allergenicity [9]
US	-Faster mass and energy transfer -Small batch continuous equipment available	-Moderate reduction of allergenicity (about 50%) -Impact on food properties at high power intensity [10]

The impact of physical treatments in the form of waves on the protein structure

Gamma irradiation - protein aggregation, crosslinking, fragmentation, and unfolding

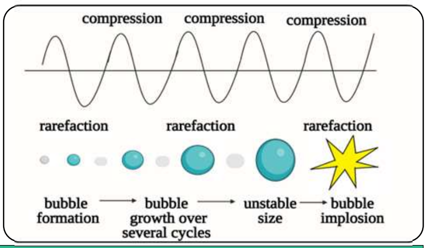
Pulsed ultraviolet light - protein aggregation and unfolding

Cold plasma - unfolding of proteins and the breaking of peptide bonds, protein aggregation

Microwave - protein denaturation, secondary structure can be altered (losses in β-sheet structures and increases in a random coil)

Ultrasonication - hydrogen bonds are affected, refolding of proteins, secondary structure can be damaged

Ultrasonication process



CONCLUSIONS

- ❑ Besides the potential use of these technologies to lower allergenicity, physical treatments better impact the product, nutritional and organoleptic characteristics.
- ❑ The most common identified modifications in proteins are denaturation, inactivation of conformational epitopes, degradation of structures, alteration of protein subunits, aggregation, and crosslinking.
- ❑ Extrusion seems to be today the most convenient technology to reduce soy allergenicity, in terms of high productivity, low cost of equipment, and improved protein digestibility.
- ❑ Combination of different processes provides new strategies for the reduction of soybean allergenicity.
- ❑ Some challenges and limitations must be addressed for all technologies before replacing conventional methods entirely.

REFERENCES

1. https://doi.org/10.1080/10408398.2015.1045965
2. https://doi.org/10.1080/10408398.2020.1722942
3. https://doi.org/10.5772/intechopen.68753
4. https://doi.org/10.1016/B978-0-12-802230-6.00020-5
5. https://doi.org/10.1016/b978-0-08-100596-5.23021-7
6. https://doi.org/10.5772/intechopen.83439
7. https://doi.org/10.1016/j.ifset.2016.06.007
8. https://doi.org/10.1111/1750-3841.15556
9. https://doi.org/10.1533/9781845690212.1.76
10. https://doi.org/10.1016/j.tifs.2021.01.017

ACKNOWLEDGEMENTS: The authors would like to thank the Walloon Region for supporting this work as part of the ALLERSOJA project (WIN2WAL program, convention 1910044).