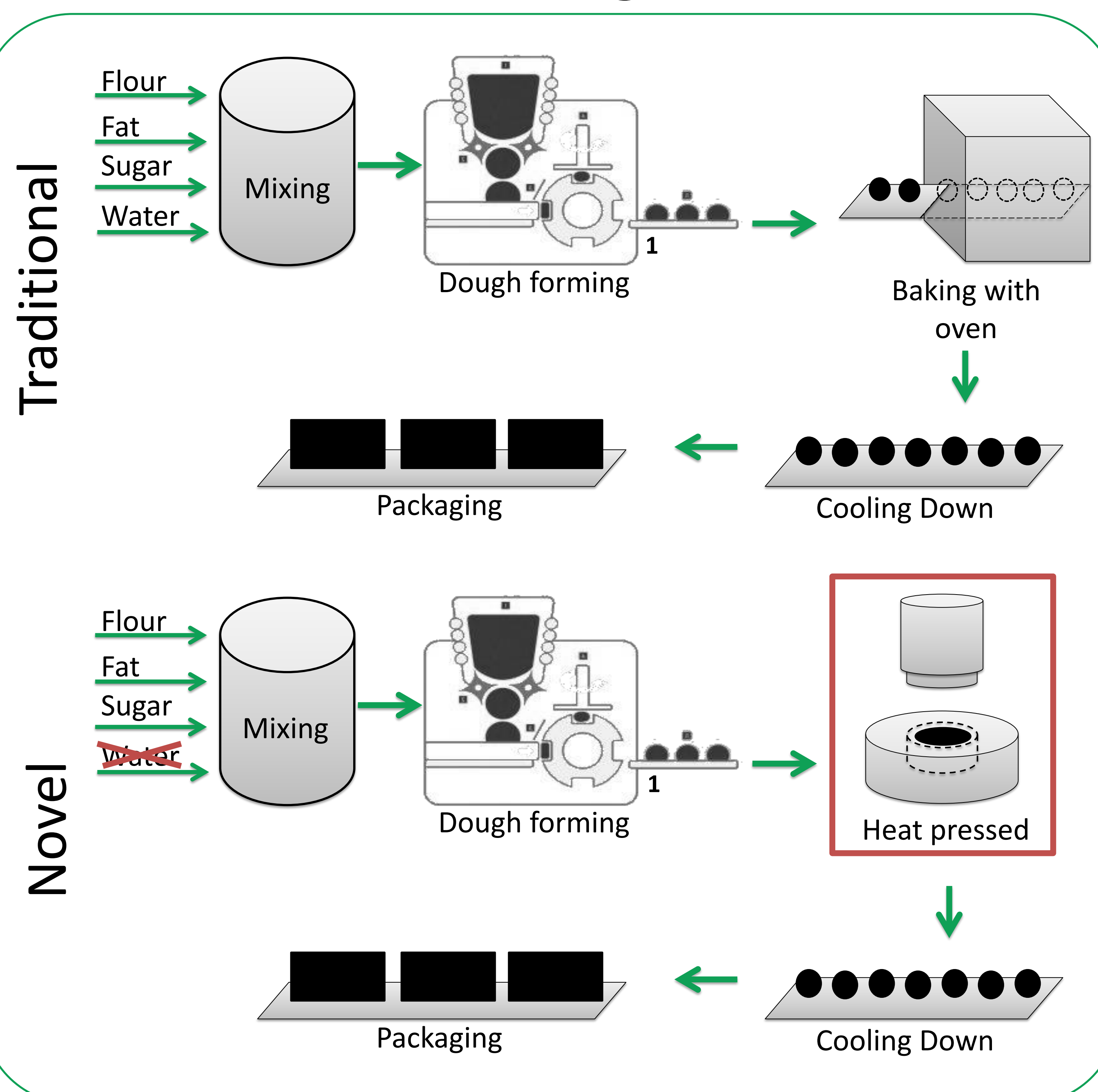


Introduction

This project concerns redesigning the manufacturing process of a traditional biscuit by investigating if ingredient conversions making a biscuit α biscuit can be brought about via an alternative process. This process may be more energy efficient, require fewer ingredients and may also generate an opportunity for manufacturers to create a healthier biscuit through redesigning the ingredient space. The working hypothesis is that a biscuit can be manufactured using a heated press whilst removing water from the ingredients.

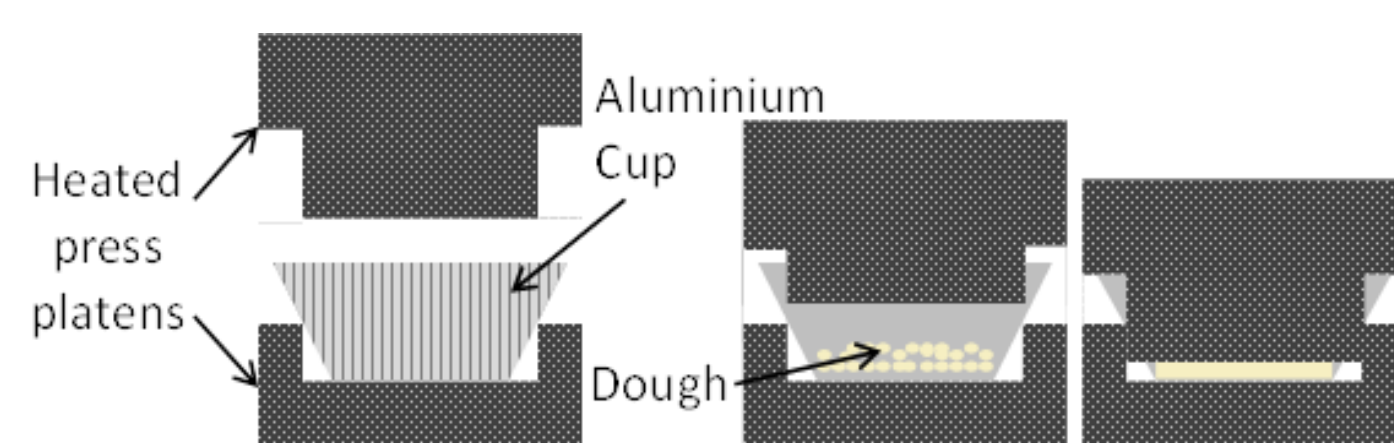
Manufacturing Process



Methods

Heated Press

A heated press is a piece of equipment which combines the use of thermal treatment and applied pressure. The upper and lower platens can be heated from 50 to 210 °C. The pressure can be set in the range of 0 to 4 bar and the upper platen will move down to press the materials for 5 seconds to as long as an hour, if needed.



Break Strength

The three point bend test was used to measure the break strength of the biscuit or the biggest amount of force the biscuit will support before breaking. The biscuit rests on two supporting beams and a third moves down to "snap" the biscuit between and parallel to the other two beams. ² Break stress was calculated to take into account the dimensions of the samples and distance between the beams. ³

$$\sigma = \frac{3LF}{2dt^2}$$

σ – Stress (N/m²) L – Distance between the supports (m)
F – Force (N) d – Diameter (m) t – Thickness (m)

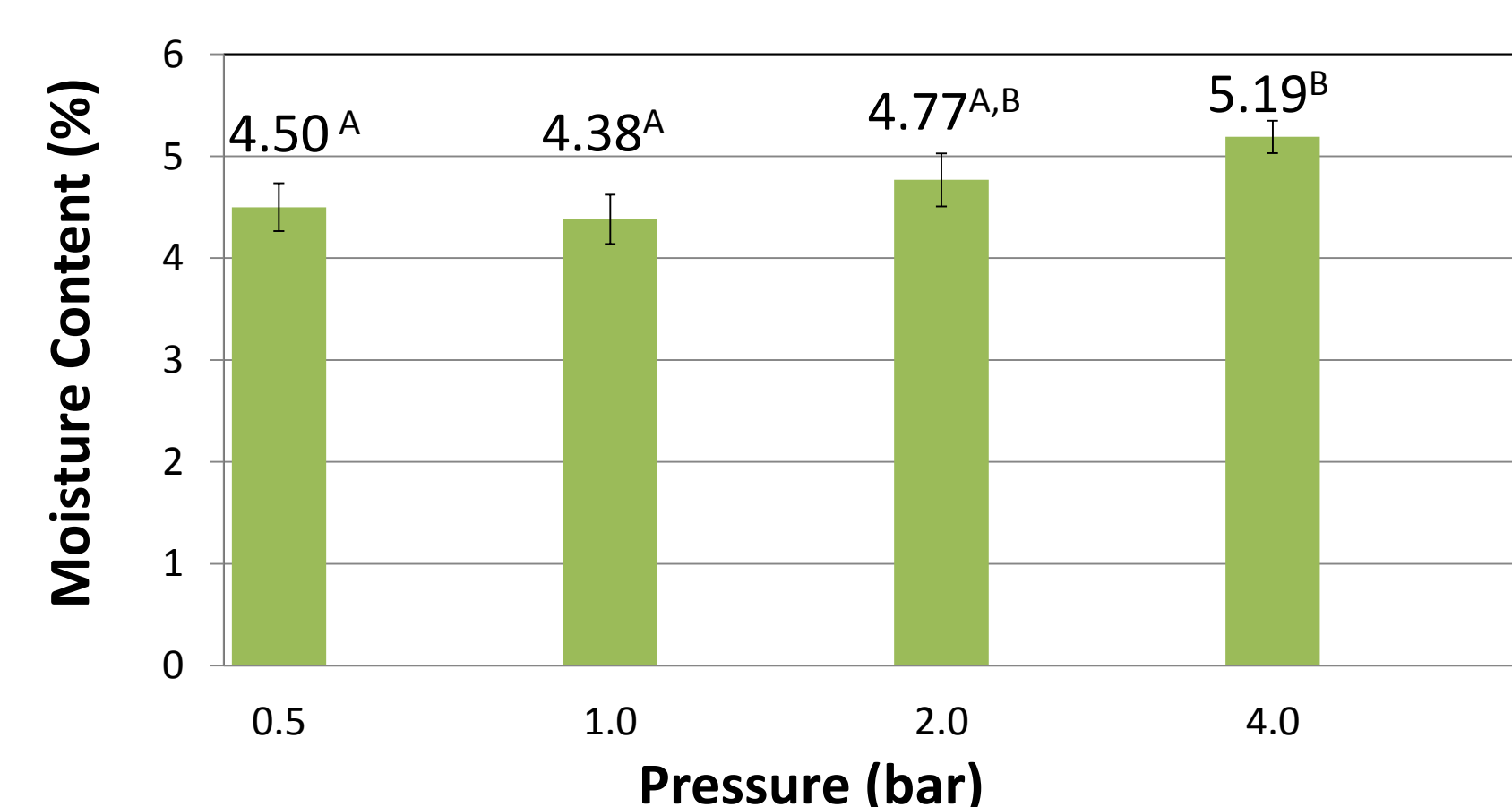


Results and Discussion

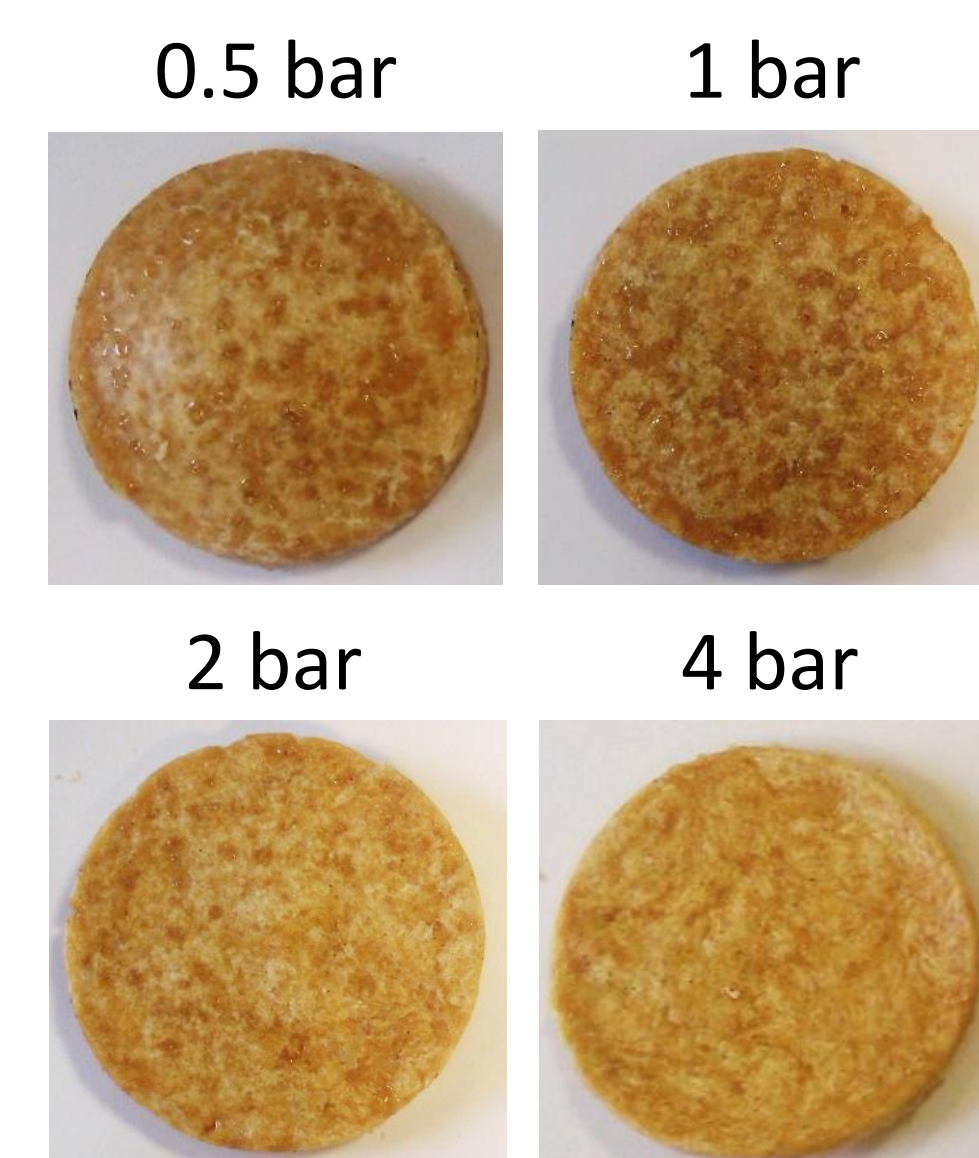
Fat and Sugar Effect

The effect of increasing sugar in the formulation was proportional to the increase of hardness of the biscuits produced. For fat, the relationship was inversely proportional. A balance with the fat and sugar content needs to be considered in order to produce a biscuit with desire texture.

Pressure Effect



Formulation 61 % flour, 30 % sugar and 9 % butter. Mass of 8 grams pressed for 180 seconds at 160 °C.

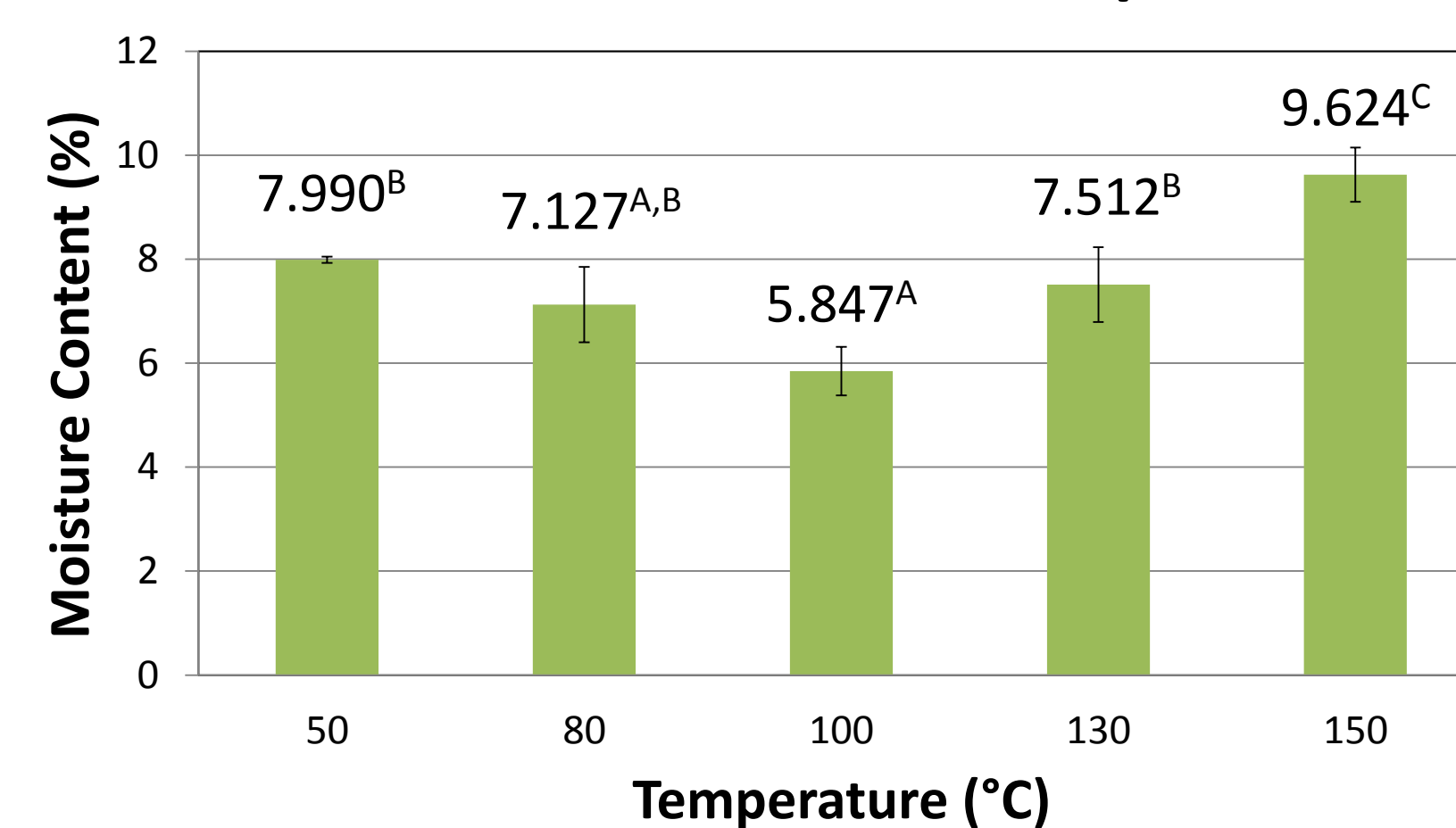


Pressure (bar)	Thickness (mm)	Break Force (N)	Break Stress (MPa)
0.5	7.787 ^A	45.416*	unmeasurable
1	7.160 ^A	50.297*	unmeasurable
2	3.839 ^B	33.826	1.913
4	2.564 ^B	29.335	3.717

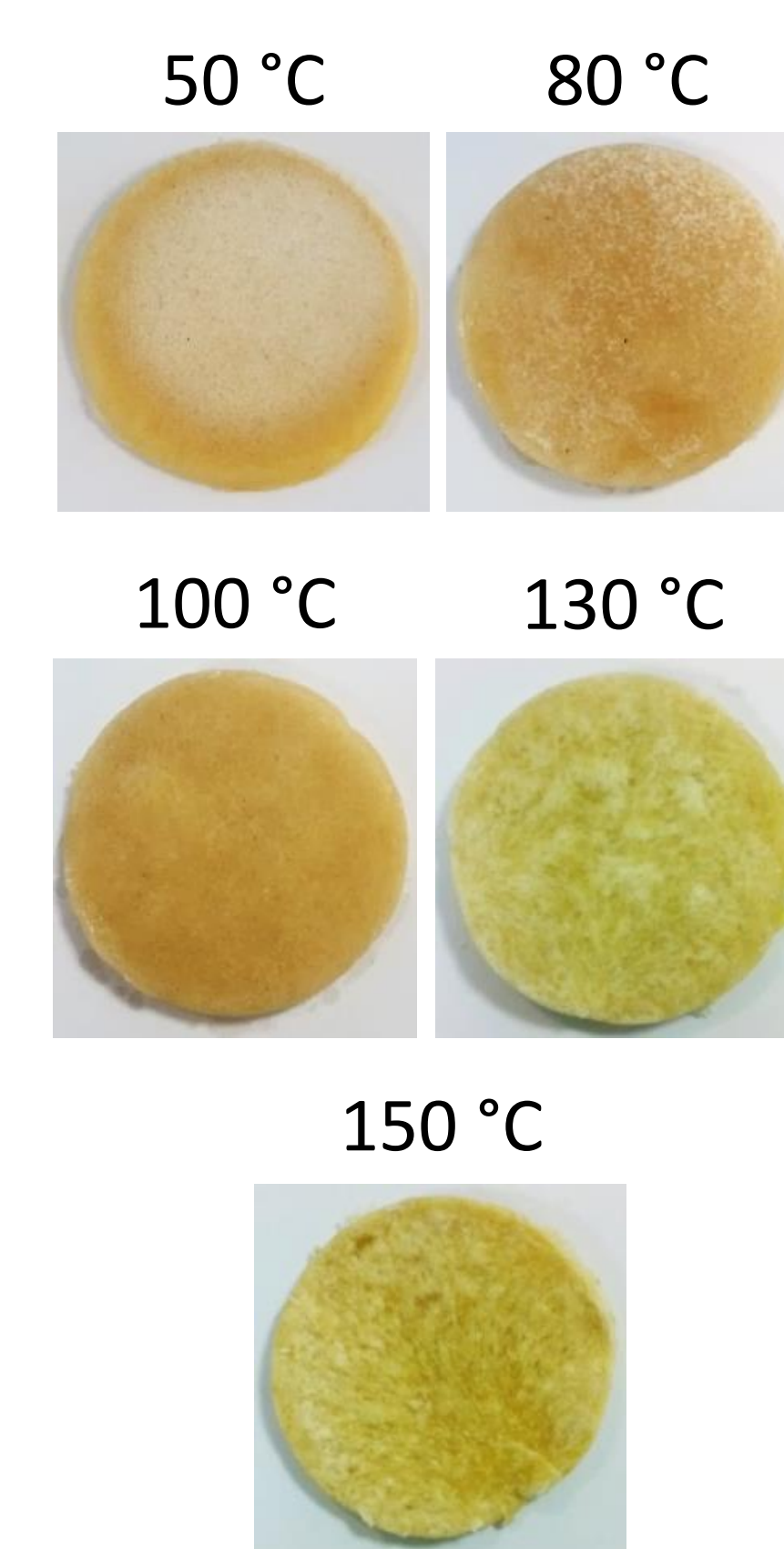
*Value of one sample.

- With an increase in pressure the moisture content increases and the appearance improves.
- Samples made with lower pressures (0.5 and 1 bar) were too hard. Applying a pressure of 2 and 4 bar decreased the hardness of the biscuit.

Temperature Effect



Formulation 60 % flour, 20 % sugar and 20 % butter. Mass of 8 grams pressed with 2 bars for 180 seconds.



Temperature (°C)	Thickness (mm)	Break Force (N)	Break Stress (MPa)	Standard Deviation
50	3.80 ^A	13.67	0.791	0.042
80	3.30 ^A	38.66	2.934	0.324
100	3.50 ^A	37.67	2.629	0.981
130	2.43 ^B	10.33	1.591	1.171
150	2.03 ^B	7.33	1.815	1.481

- An increase in temperature from 50 to 100 °C caused a decrease in moisture content and an increase in hardness.
- A further increase in temperature to 150 °C produced biscuits with a higher moisture content and therefore softer.
- Standard deviation for samples with 130 and 150 °C is high - hypothesis is an heterogeneous structure.
- Hypothesis for this non-linear relationship is case hardening of the surface of the biscuit preventing moisture migration.

Conclusions

A composite of typical biscuits materials can be processed with the heated press. The dough powder forms a composite without the addition of extra water by compressing the materials. The break stress of the biscuits decreased along the study and was highly related to the sugar content in the formulation. Future research should aim to reduce the moisture content and the stress needed to break the biscuits; this could give space for new and healthier ingredients to be used. Equipment with flexible temperatures and pressure variation to create different profiles will help further investigation. It can be concluded that processing parameters with similar formulations to the ones studied can be in the range of 30 to 180 seconds, temperature from 100 to 180 °C, pressures from 2 to 4 bar and mass from 5 to 8 grams.

References:

- (1) Image retrieved from www.koenig-rex.com
- (2) BOURNE MC. 1982. Food texture and viscosity: concept and measurement. New York: Academic Press, Inc. 325 p.
- (3) MAZEL, V., DIARRA, H., BUSIGNIES, V. & TCHOLOFF, P. 2014. Study of the validity of the three-point bending test for pharmaceutical round tablets using finite element method modeling. *J Pharm Sci*, 103, 1305-8.