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IN VITRO MONITORING OF SODIUM RELEASE DURING CARROTS CHEWING: INFLUENCE OF SALTING PRACTICES



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Introduction

Discretionary salt (DS) contributes significantly to salt intake [1] and its use might increase in the future [2]. The transdisciplinary research project Sal&Mieux aims at optimizing the use of discretionary salt by citizens when cooking and seasoning to contribute to lower the dietary sodium intake. To do so, we set up a sensory experiment on boiled carrots and we modulated salt addition, either during or after the cooking process and with different types of salt. The sensory evaluation with untrained panelists showed that a higher salty taste intensity was perceived when salt was added after cooking [3].

Hypothesis: Adding salt after cooking leads to a heterogeneous distribution of salt at the surface of the food matrix and maybe a weaker binding to the food matrix [4], which may produce a pulse of saltiness at the beginning of the food oral processing [5]. A higher saltiness perception would result from this mechanism.

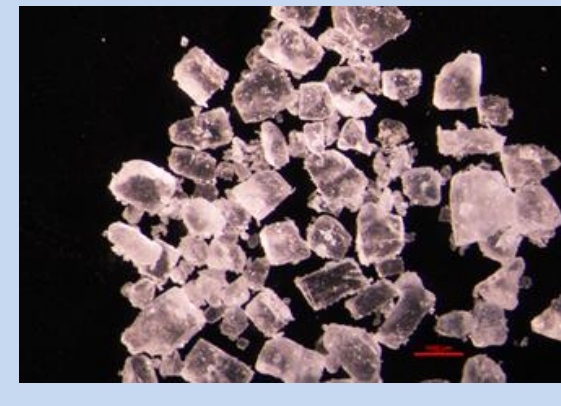
To confirm this hypothesis, we set up an experiment to monitor the release of sodium during an *in vitro* mastication process of carrots prepared following three different salting conditions namely no salt added, fine sea salt added during cooking and flower of salt added after cooking.

Materials and methods

Salting modalities:

SALT ADDED

At the beginning of cooking (in water)



Fine sea salt

After cooking (poured on the food)



Flower of salt

No salt added

Chewing simulator:



Superior jaw



Inferior jaw



Before and after mastication (1, 2, 3, 4, 5, 6 or 8 chewing cycles)

Chewing simulator parameters

Mastication force – 150 N

Shear angle not used

Number of chewing cycles – 1, 2, 3, 4, 5, 6 or 8

Artificial saliva with known composition [6], 2 mL at once, poured directly in the inferior jaw before adding the carrots

3 replicates per chewing cycle

Average duration of the mastication process: 35 s



Bowl collection 3 min



Saliva collection 3 min

Quantification of Na⁺ by ionic chromatography for sodium release monitoring

Sensory analysis:



70 naïve participants

57 % female
Mean age 40 yo

Asked to rate saltiness intensity

Carrots cooked for 25 min into boiling water then cut in slices and stored in a water bath

Results

Scans of food bolus after the different chewing cycles

In vitro



1 cycle



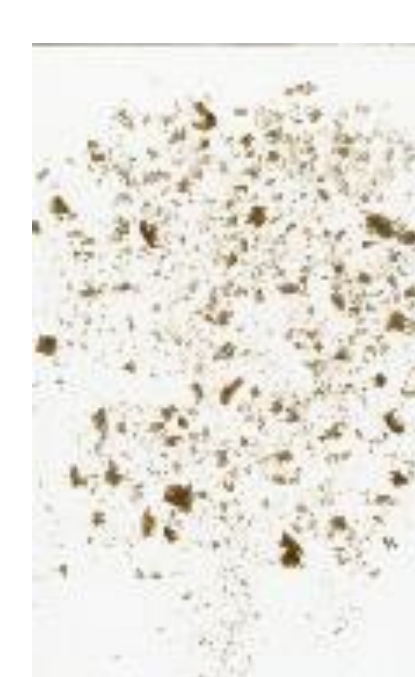
2 cycles



4 cycles



6 cycles



8 cycles



10 cycles



12 cycles

In vivo



2 cycles



12 cycles

Na⁺ release dynamic

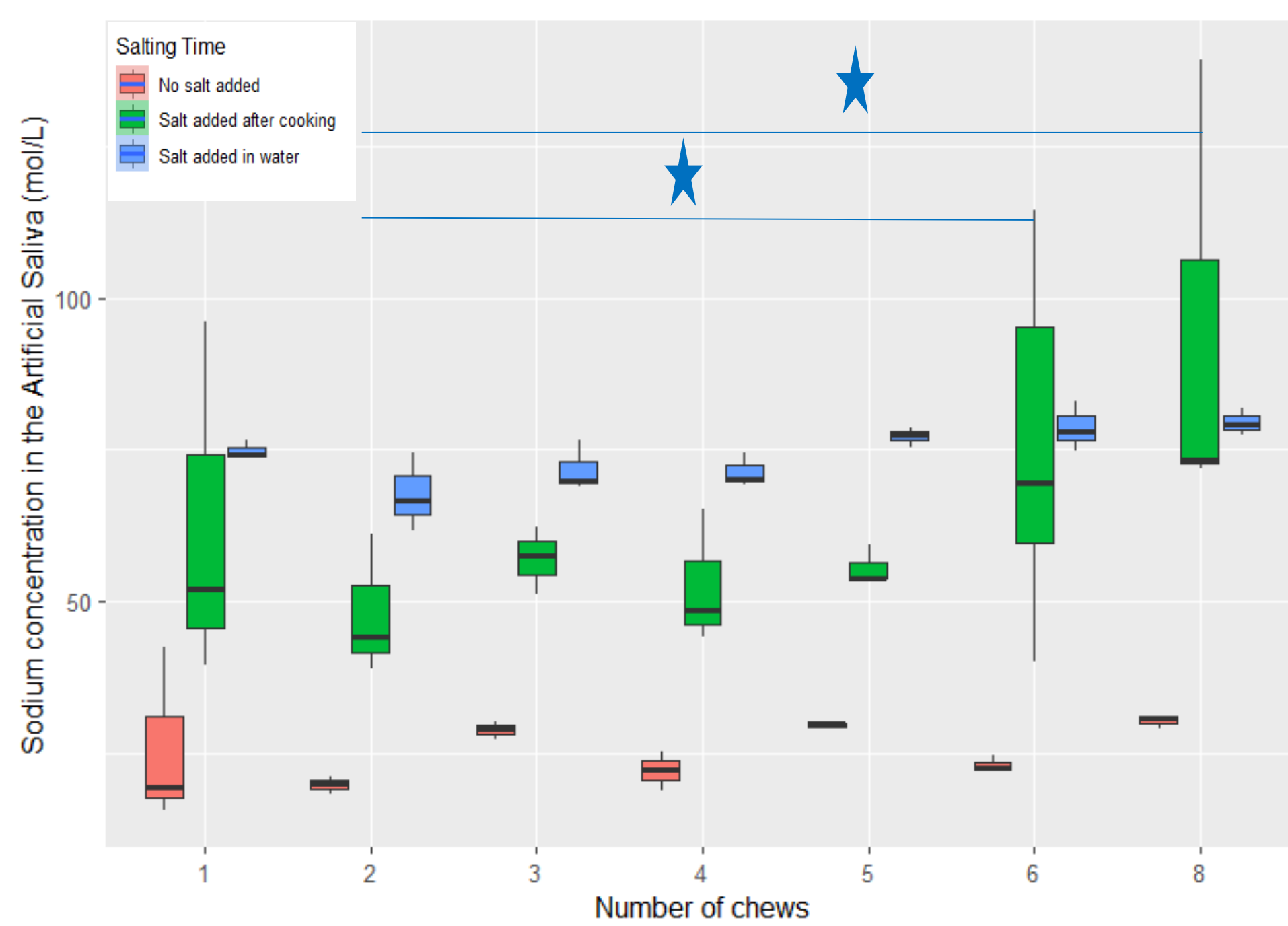


Fig.1: Sodium release monitoring during mastication

The number of chewing cycles significantly influence the dynamic of sodium release during mastication when salt is added at the beginning of cooking, in water (ANOVA, $p = 0,01$) (fig.1 – blue boxes)

The number of chewing cycles marginally influence the dynamic of sodium release during mastication when salt is poured after cooking (ANOVA, $p = 0,06$) (fig.1 – green boxes)

The number of chewing cycles does not influence the dynamic of sodium release during mastication when no salt is added during cooking (ANOVA, $p = 0,23$) (fig.1 – red boxes)

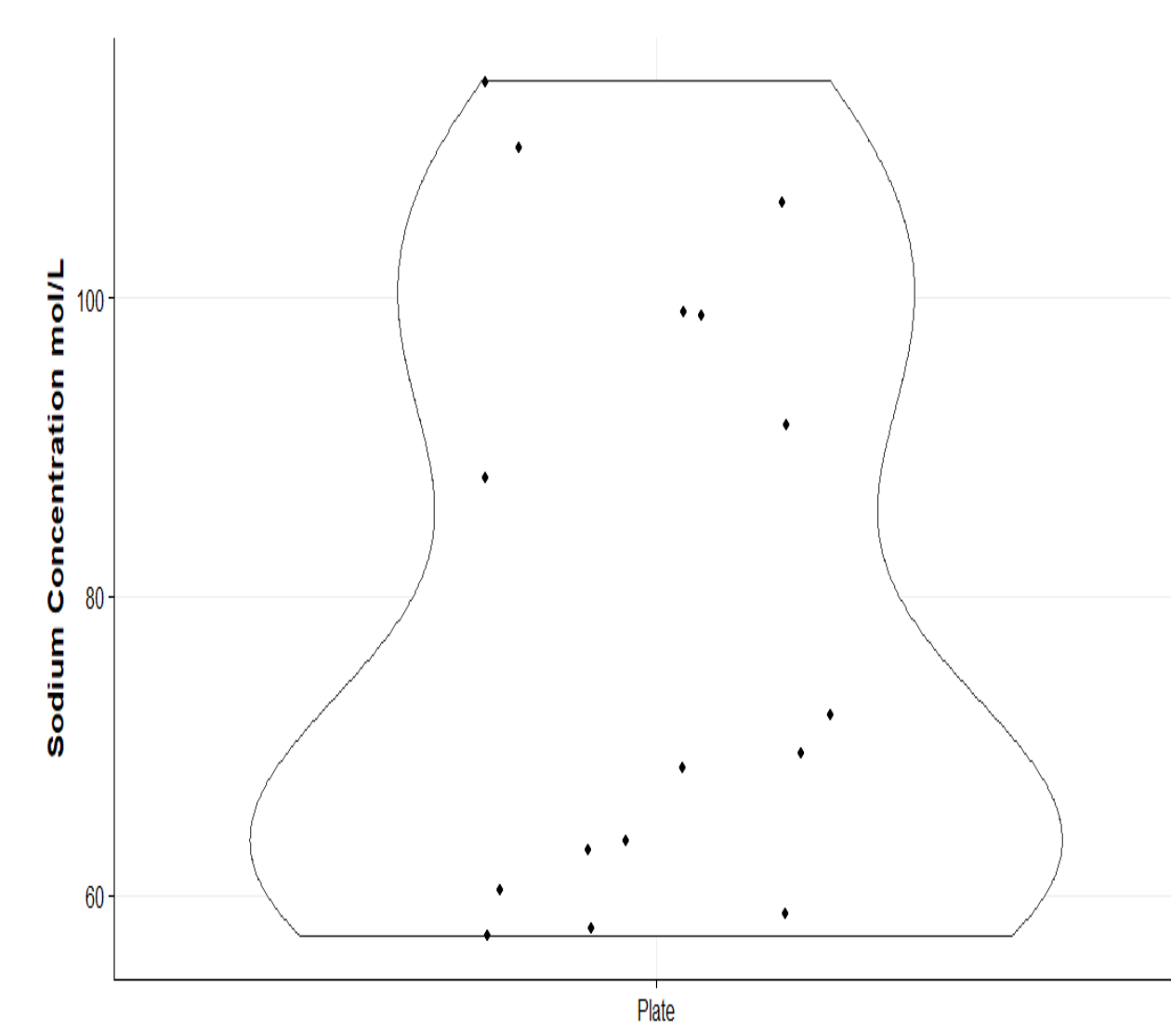


Fig.2: Sodium release after 6 chewing cycles when salt is added after cooking (n=16 replicates)

High variability observed when salt is added after cooking (fig.2)

Sensory analysis

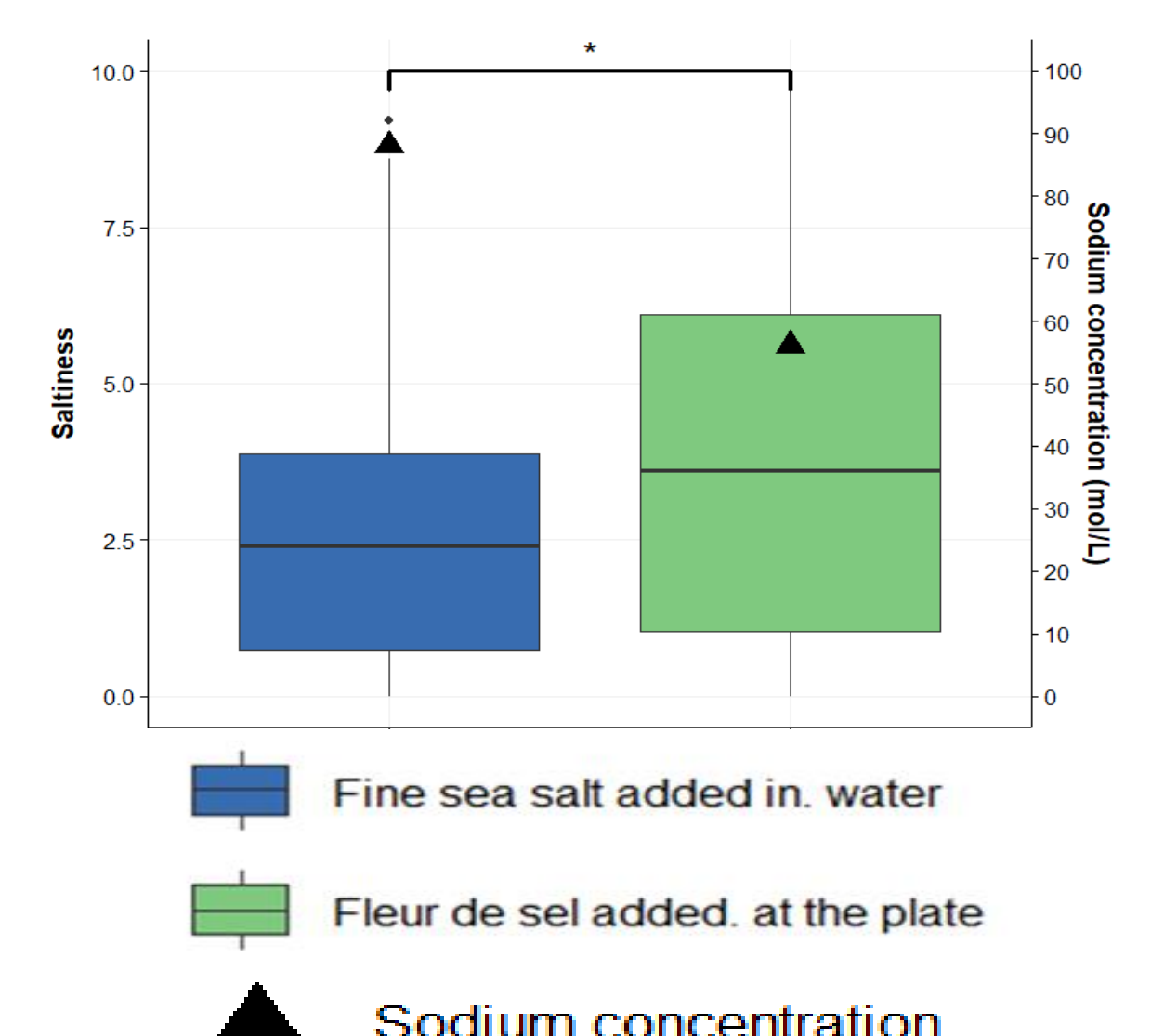


Fig.3: Intensity of saltiness perception of carrots salted at the beginning of cooking (in water) or after cooking

Mean of the blue box: 2.9
Mean of the green box: 4.0
Sodium reduction for the green box: 30%

Discussion

Sodium release kinetic during mastication seems to be similar whenever the salt is added, at the beginning of cooking or after cooking (fig.1). However, the difference between the two salting modalities is the variability which is greater when the salt is added after cooking (fig.1 and fig.2). This variability may induce a boost of salt occurring at one point during the food oral processing and not only at the beginning. This pulse of Na⁺ can explain the higher saltiness perception observed in the sensory studies (fig.3) [5].

Where does this variability come from? Perhaps, salting after cooking induces a heterogeneous distribution of salt crystals and maybe a weaker binding to the food matrix.

NMR and MRI analysis are under way to investigate the sodium distribution in the food and the influence of salting practices on sodium interaction with the food matrix.

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