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The 3rd International Conference on Sustainable Global Agriculture and Food (November 2018)

CAN DOMESTIC PROCESSING BE STANDARDIZED TO OPTIMIZE GLUCOSINOLATES IN *BRASSICA* VEGETABLES?

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ABSTRACT

Brassica vegetables, e.g. cabbage, broccoli, and cauliflower, are consumed mostly after being processed, either at domestic (households and small-scale establishments) or industrial levels. Unfortunately, processing can affect to various changes in the content of glucosinolates, a group of plant secondary metabolites commonly found in *Brassica* vegetables. Glucosinolates in these vegetables have been largely investigated for their beneficial effect on reducing risk of several cancers. Moreover, studies on the effect of processing, such as boiling, steaming, frying, microwave cooking, fermentation, and canning, on glucosinolate content have been extensively performed. The large variety in processing methods affect the glucosinolate content, particularly due to processes that allow for enzymatic hydrolysis and thermal degradation of glucosinolates, and leaching of the bioactive components. Domestic processing methods have different technology and managerial approach than industrial processing. Apparently, it is more difficult to produce standardized products by domestic processing due to its high variability of materials and processing methods. The fate of glucosinolates in *Brassica* vegetables during different processing methods by using a mechanistic approach will be described. Subsequently, discussion will be continued by conveying challenges and opportunities of both domestic and industrial processing methods to optimize glucosinolates by incorporating a techno-managerial approach. Eventually, these will contribute in designing processing methods, especially for small scale food establishments and households, for improving health beneficial properties of the products.

Keywords: Brassica vegetable, glucosinolate, processing, domestic, industry, health

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Faculty of Agricultural Technology

- Food Technology (Undergrad & Master)
- Nutrition & Culinary Tech (Undergrad)

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CAN DOMESTIC PROCESSING BE STANDARDIZED TO OPTIMIZE HEALTH PROMOTING COMPOUNDS IN VEGETABLES?
[Learning from Glucosinolates in *Brassica* Vegetables]

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@ the 3rd ICSAF | STU Vietnam | 09 Nov 2018

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INTRODUCTION

- Various studies on the association of plant-based food intake with the risk of disease

- Glucosinolates (GSs) in *Brassica* vegetables and their breakdown products (particularly isothiocyanates) have been extensively investigated for their beneficial effects on human health.

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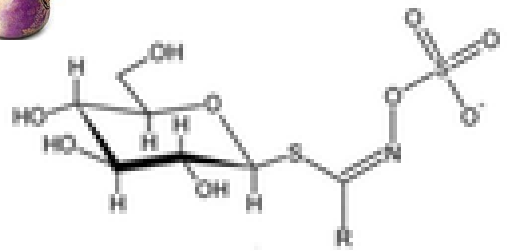
- *Brassica* vegetables are mainly processed / cooked [domestically] prior to consumption

Glucosinolate

Thiohydroximate-O-sulfonate



+ H_2O —Myrosinase (metal ions, ascorbate)→ [R, SH, $NOSO_3^-$] + glucose

pH 4
ESP
TFP
NSP

ESP
TFP

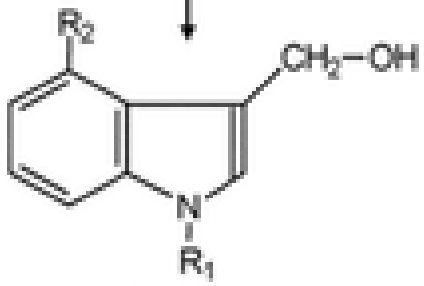
TFP

Indoles

pH 6-7
ESM

Nitriles

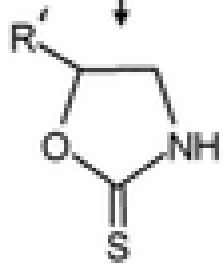
Thiocyanates



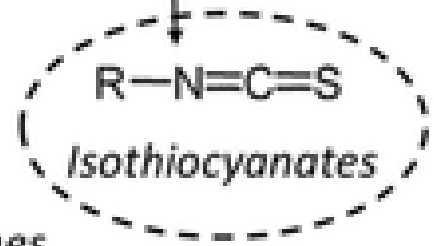
e.g. Indole-3-carbinol

R″

Epithionitriles



Oxazolidine-2-thiones



Isothiocyanates

Taken from Oliviero et al., 2018

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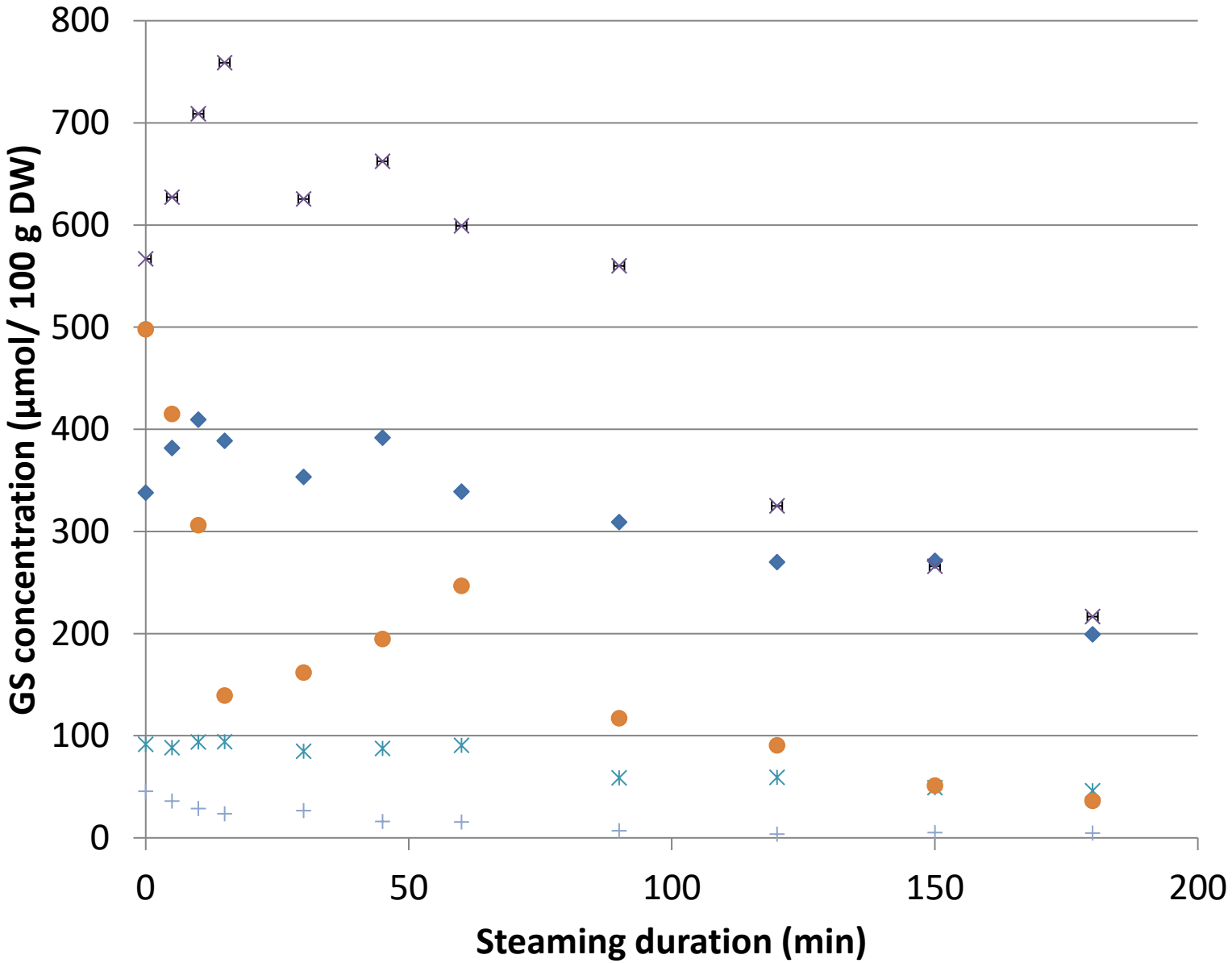
SOME EXAMPLES

GSs IN CABBAGE-ROLL DURING LONG-TERM STEAMING (Nugrahedi et al., 2016)

- Cabbage rolls
- Part of "siomay" dish
- Short boiling the leaves (3 min)
- Folded and rolled
- Steaming (up to 180 min)



Others reported: Retention of total GSs after steaming

- 81.2 % (Volden et al. 2008)

- 138.9 % (Pellegrini et al. 2010)
- 84.5 % (Yuan et al. 2009)

GSs DURING FERMENTATION OF *BRASSICA JUNCEA* [MAKING *SAYUR ASIN*] (Nugrahedi et al., 2014)

- "*Sayur asin* ": Fermented *Brassica juncea*
- Withering – Salting – Fermenting
- Three withering methods:

(1) Oven 35 °C, 2.5 h

(2) Microwave 180 W, 4.5 min

(3) Microwave 900 W, 2 min

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GS concentration (µmol/ 10 g DM) during the production of *sayur asin*

	Withering treatment	Fermentation (days)			
		1	3	5	7
Sinigrin	Oven	4.5	n.d.	n.d.	n.d.
	MW 180	3.3	n.d.	n.d.	n.d.
	MW 900	22.6	12.3	11.3	11.4

Others reported: Retention of total GSs after fermentation

7

- No GSs in fermented cabbage and stored sauerkraut, irrespective of cabbage cultivation season, fermentation type, and salt concentration (Martinez Villaluenga et al., 2009; Daxenbichler et al., 1980; Ciska and Pathak, 2004).

turnitin Page 16 of 34 - Integrity Submission Submission ID trn:oid:::28973:129636089

GSs IN CHINESE CABBAGE AND PAKCHOI DURING STIR-FRYING (Nugrahedi et al., 2017)

- Chinese cabbage (*Brassica rapa* ssp *pekinensis*)
- Pakchoi (*Brassica rapa* ssp *chinensis*)
- Pan temperatures: 160, 200, 225, 250 °C
- Frying time: 1, 2, 4, 8 min

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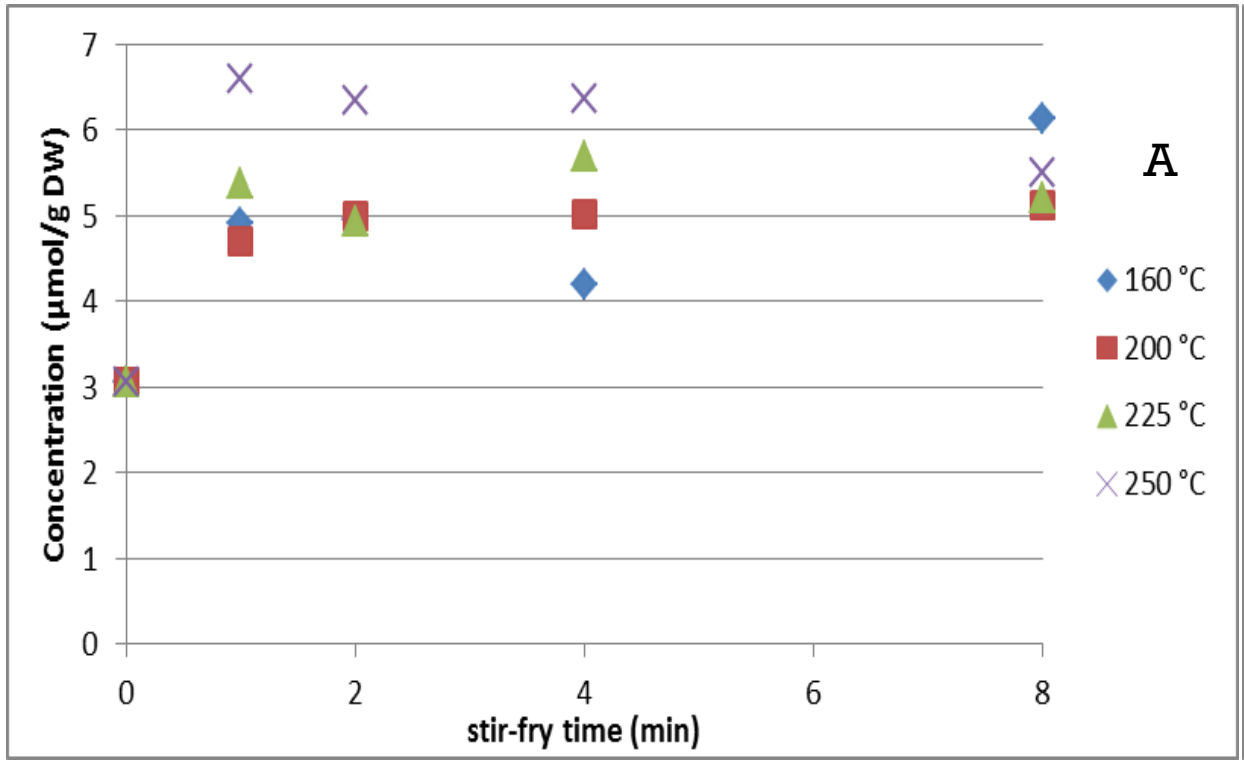
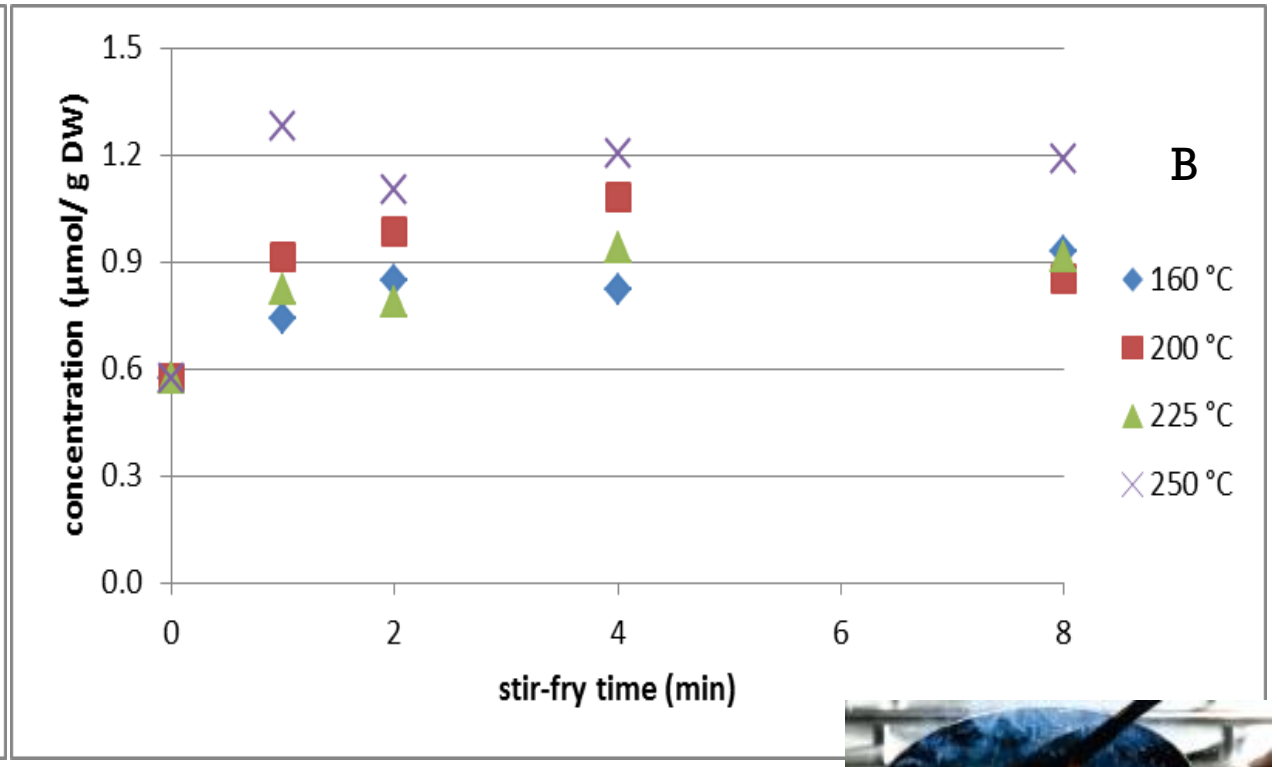
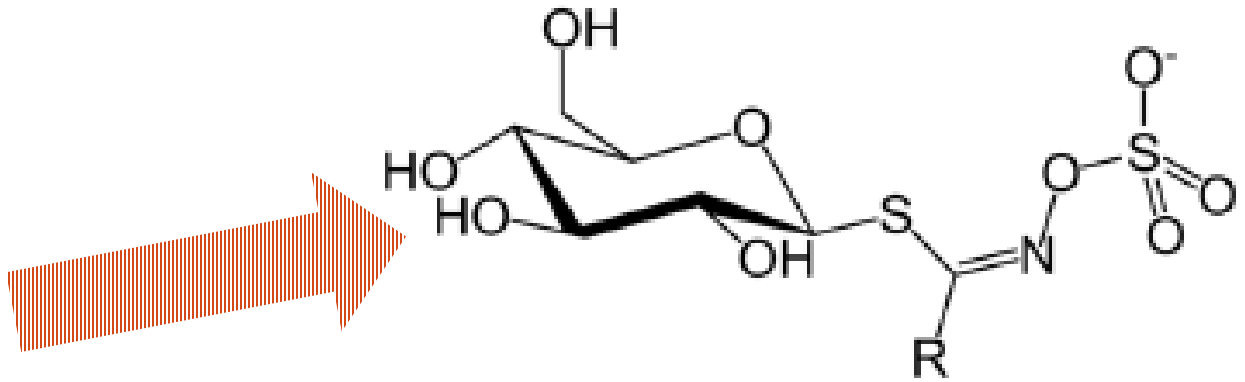
TOTAL GSs (A) & TOTAL INDOLYL GSs (B) IN CHINESE CABBAGE DURING STIR-FRYING





Others reported: Retention of total GSs after stir-frying

- 98.7 % (Rungapamestry et al. 2008)
- 51- ~100 % (Moreno et al. 2007)



Different conditions in processing lead to various levels of GSs

- **Can one standardize these domestic processing/ preparation methods?**

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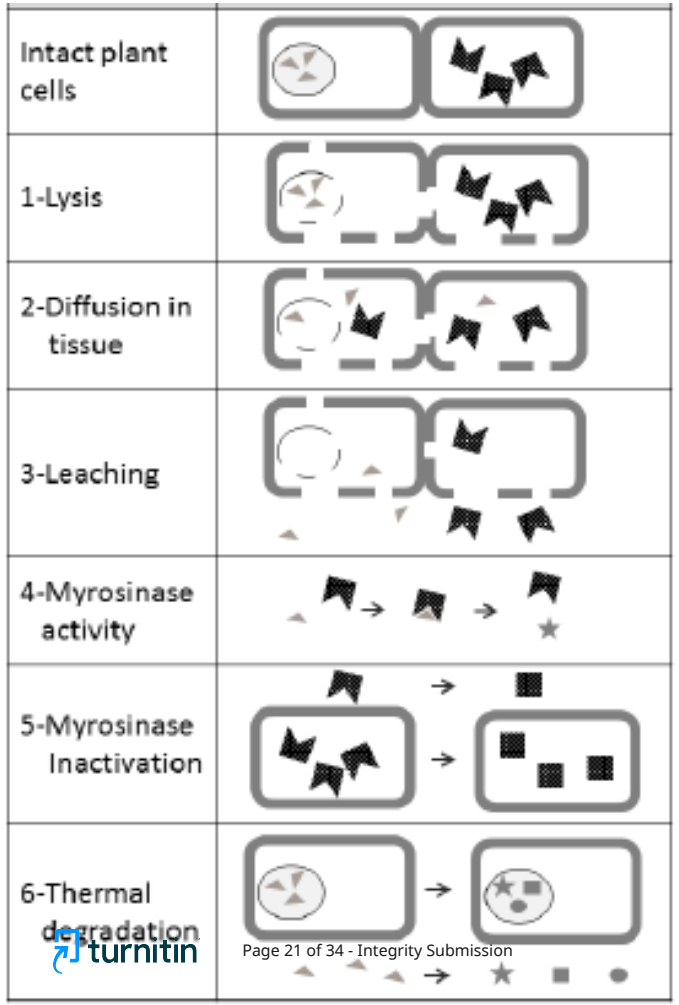

A MECHANISTIC APPROACH (Nugrahedi et al., 2015)

Mechanism	Preparation method				
	Boiling	Steaming	Blanching	Microwaving	Stir-frying
Lysis	+	+	+	+	+
Diffusion in tissue	+	+	+	+	+
Leaching	+	+/-	+/-	+/-	-
Myrosinase activity	-	+/-	-	-	-
Myrosinase inactivation	+	+	+	+	+
Thermal degradation	+/-	+/-	+/-	+/-	+

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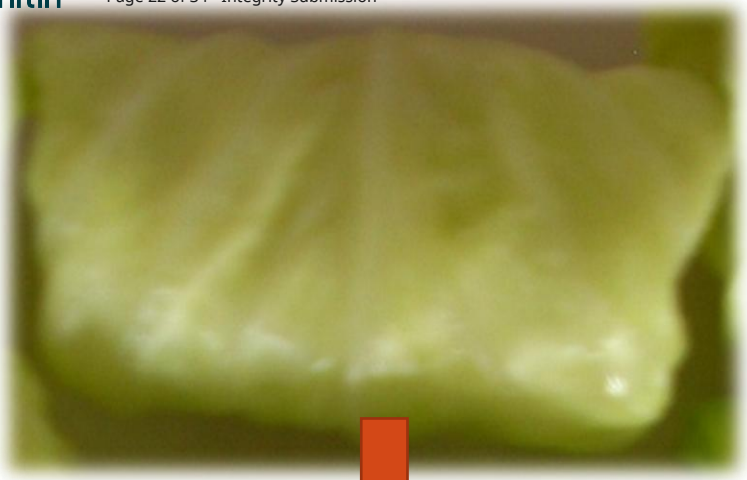
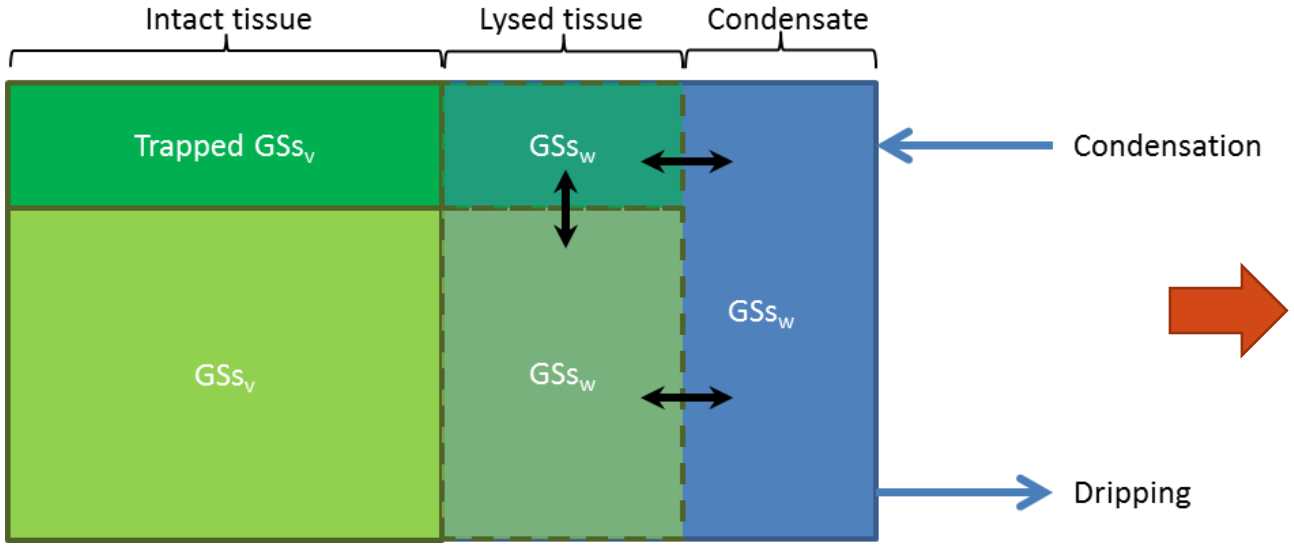
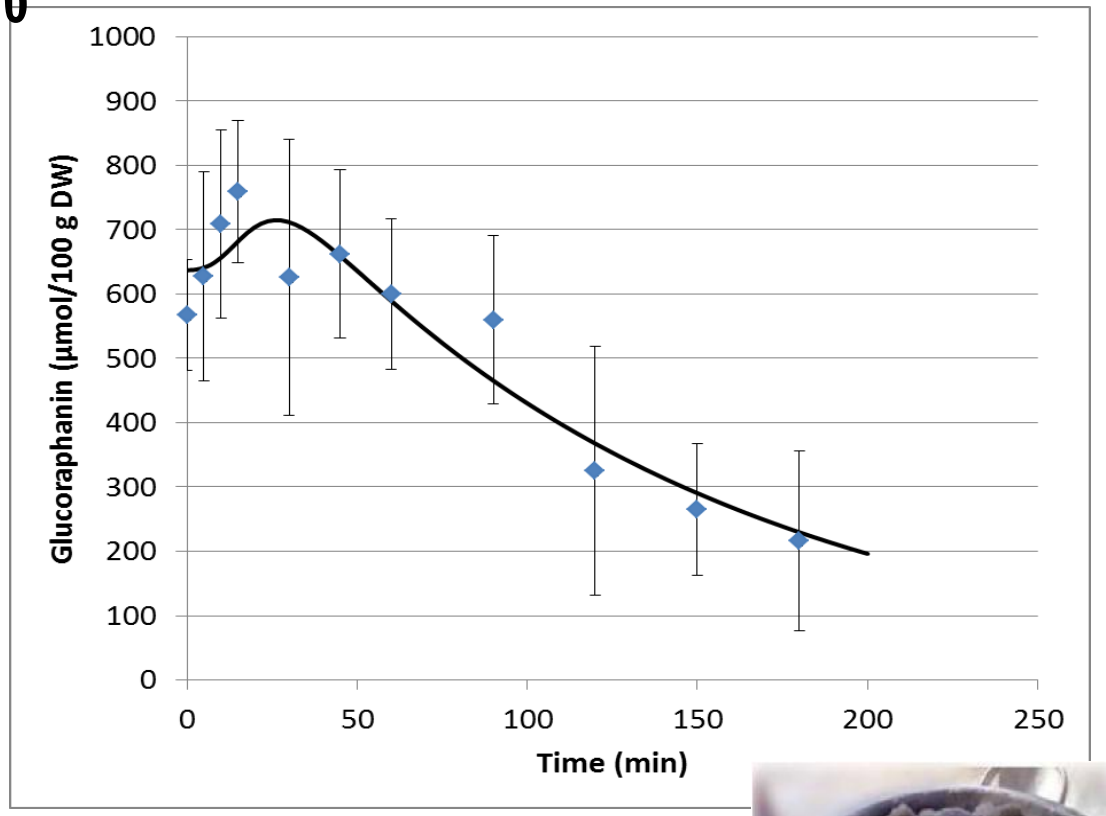


mathematical modelling approach on steaming (Nugrahedi et al., 2016





2 Schedule of the vegetable tissue during steaming consisting of different compartments.

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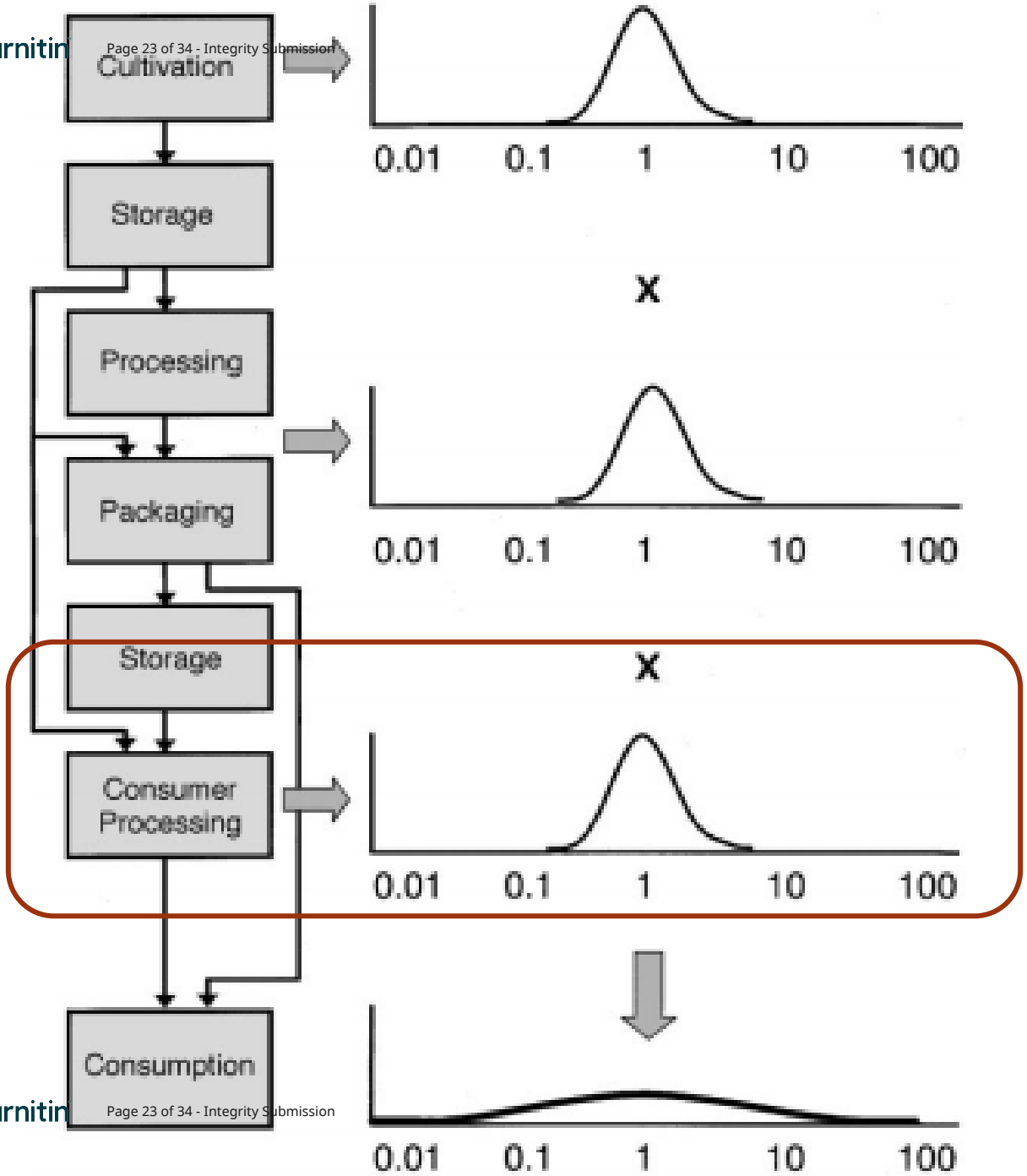

2

Variation in phytochemical (GS) levels at three levels in the food production chain and the resulting overall variation in intake levels at the consumer level (taken from Dekker et al., 2000)

HOW DO THEY COOK? (Nugrahedi et al., 2015)

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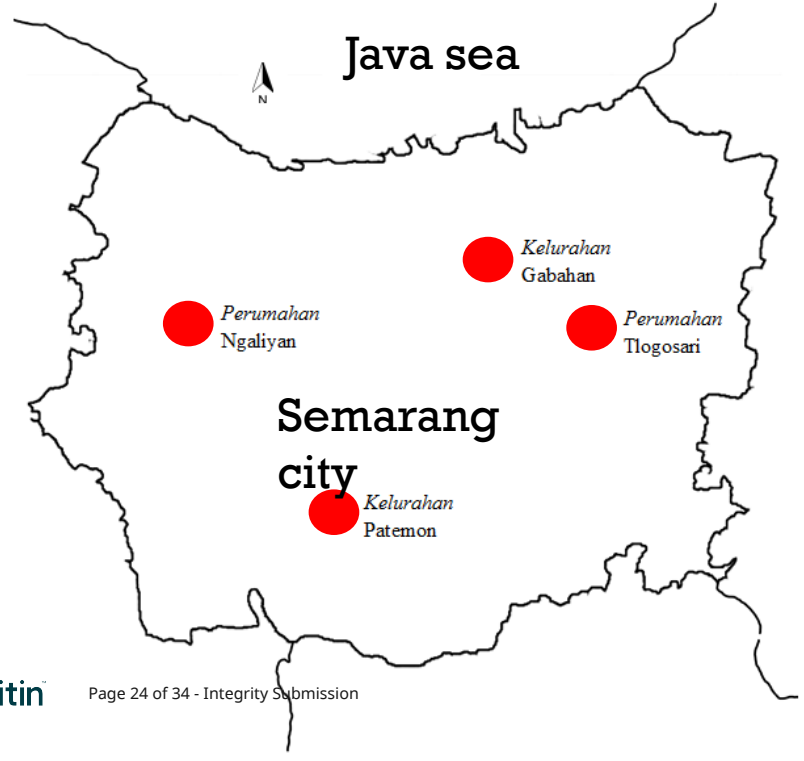
Practices and health perception of preparation of *Brassica* vegetables



- Semarang city, Central Java
- Food handlers:

- FSEs = 123 respondents

- Households = 200 | 477 respondents

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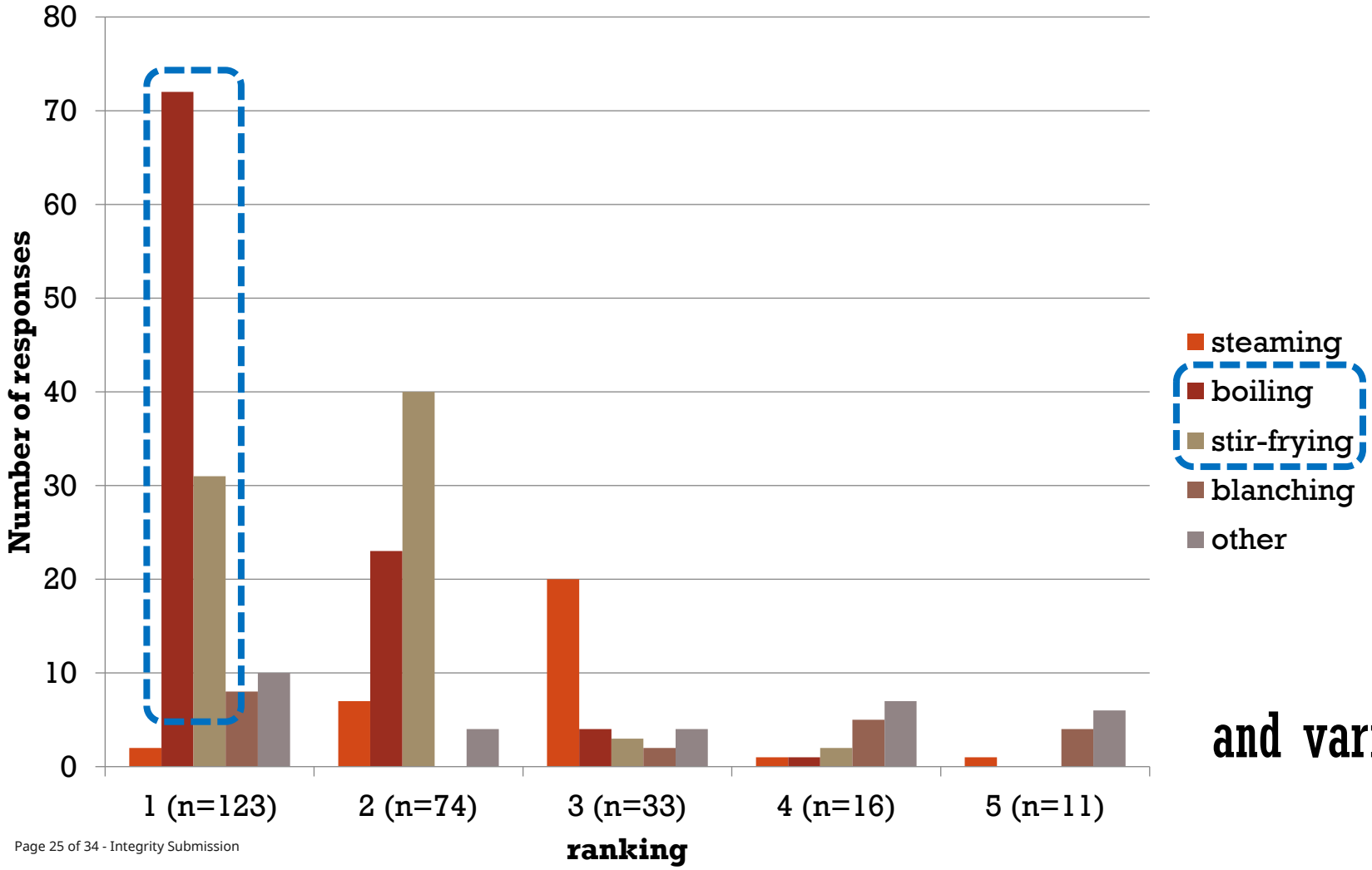
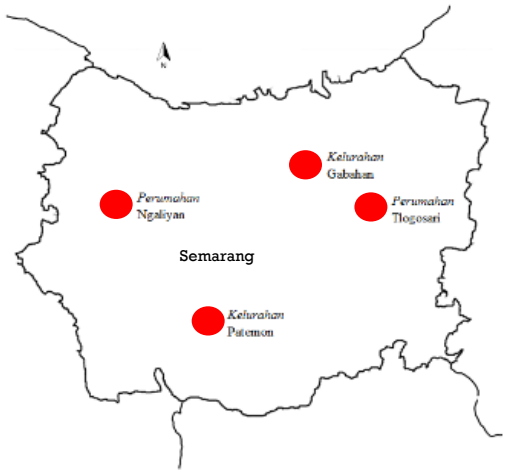
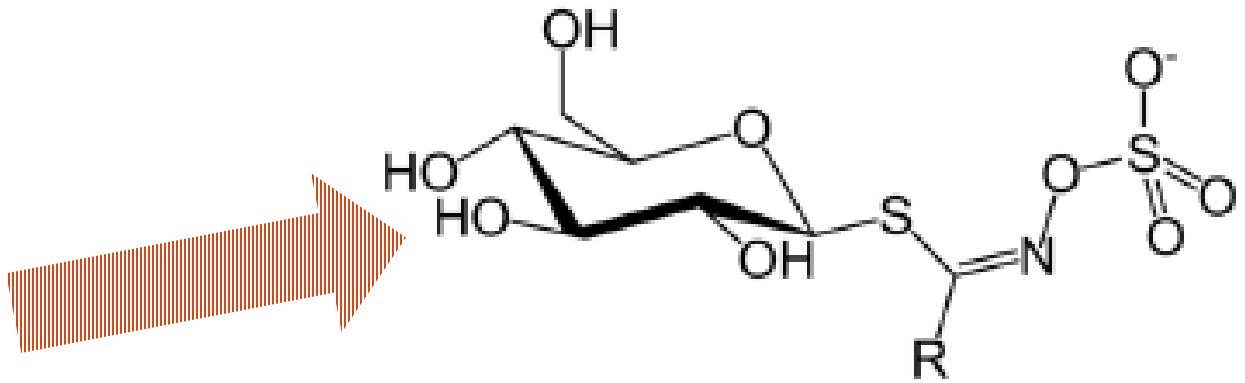
Food Service Establishments

FREQUENCY OF PREPARATION TECHNIQUES





and various (subtle) techniques



Bio-materials – technology – human lead to various levels of GSs

- **Do we have to standardize these domestic processing/ preparation methods?**

Learning from other studies:

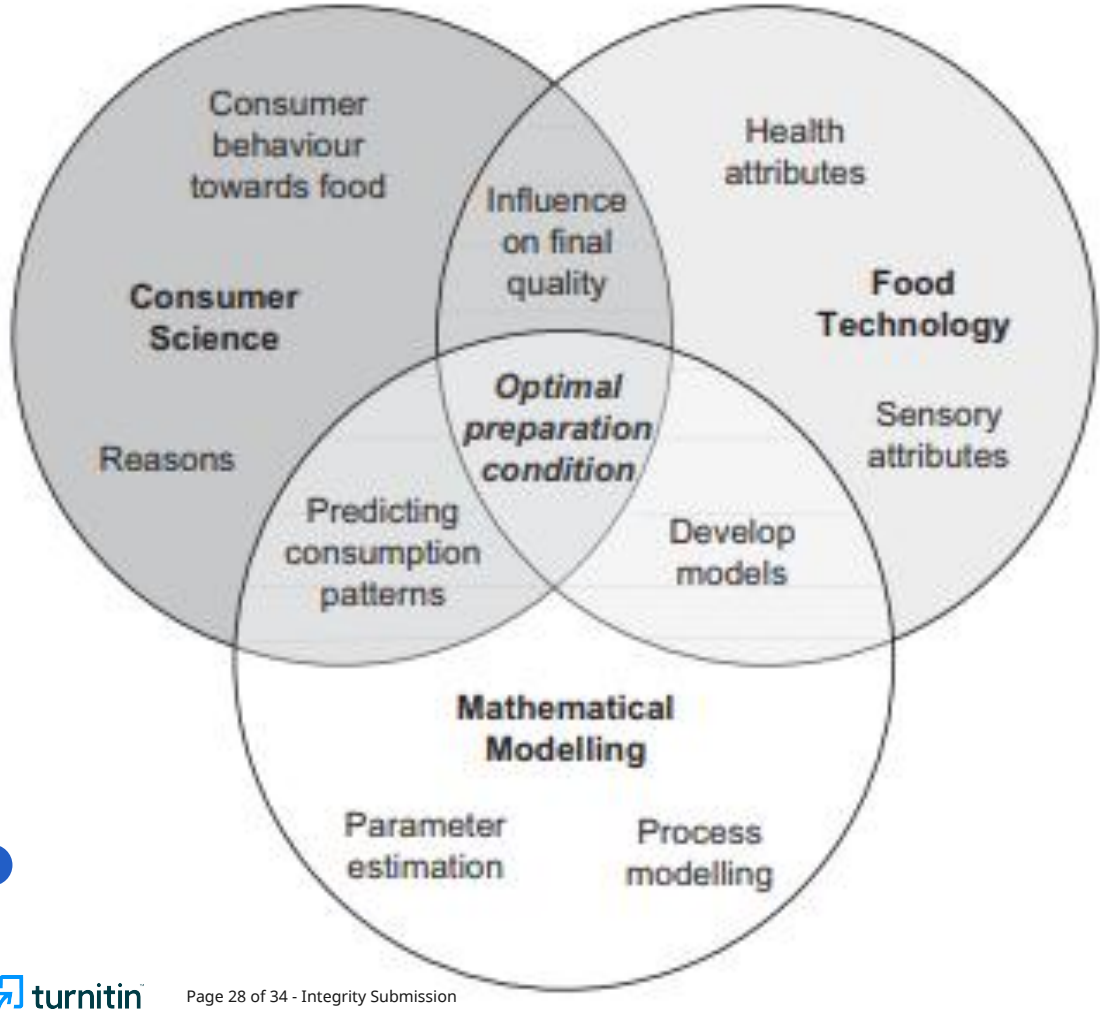
5 *Impact of control behaviour on unacceptable variation in acrylamide in French fries* (Sanny et al., 2010)

3
- Four types of control decision at the critical points that can reduce variation in acrylamide concentration:
  1. Product properties
  2. Technological conditions
  3. Food handler behaviour
  4. Administrative conditions

3
- variable daily decisions may be still a considerable source of variation?

Learning from other studies:

4



2

Studying consumer behaviour related to the quality of food: A case on vegetable preparation affecting sensory and health attributes (Bongoni et al., 2013)

Fig: The Consumer-Oriented Food Technology approach (taken from Bongoni et al., 2013)

1

Most culinary creations were never designed in the engineering sense they evolved by successive trial-and-error attempts. Recipes list the ingredients and their proportions quite accurately, but they describe the **culinary procedures in a rather unprecise way** (Aguilera, 2018)

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1

Knowledge on unit operations, process equipment, food material science, mathematical modelling, digital technologies, … should be mobilized into the kitchens (Aguirela, 2018)


SPYCE

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CONCLUSION

- Standardization of (domestic) processing is underway, including to achieve the optimum amount of health promoting compounds
- Yet, there is a need for integrating knowledge on food science & technology, nutrition, (molecular) gastronomy, and human behaviour both at industrial and domestic levels

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Thank You