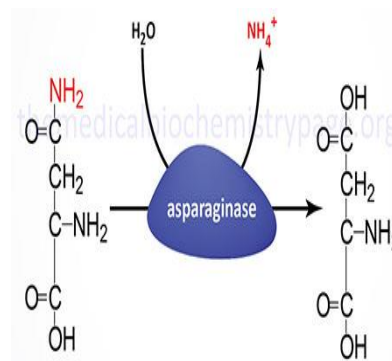
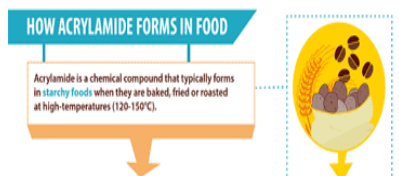


# ACRYLAMIDE REDUCTION IN FRIED POTATO SLICES AND STRIPS BY USING ASPARAGINASE IN COMBINATION WITH CONVENTIONAL BLANCHING

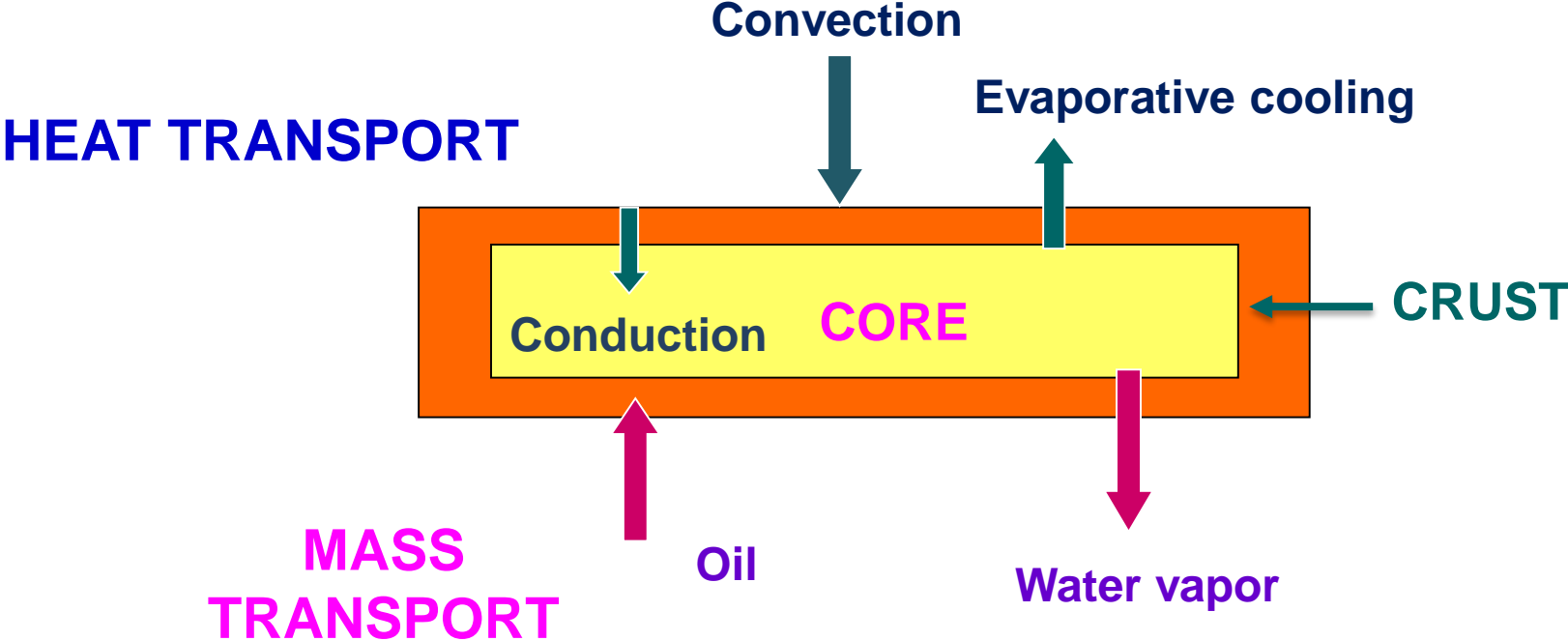


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**Departamento de Ingeniería Química y Bioprocesos**

**Pontificia Universidad Católica de Chile**

# SCHEMATIC REPRESENTATION OF THE IMMERSION FRYING OF A POTATO STRIP (“FRENCH FRY”)



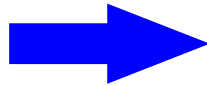
**Chip**



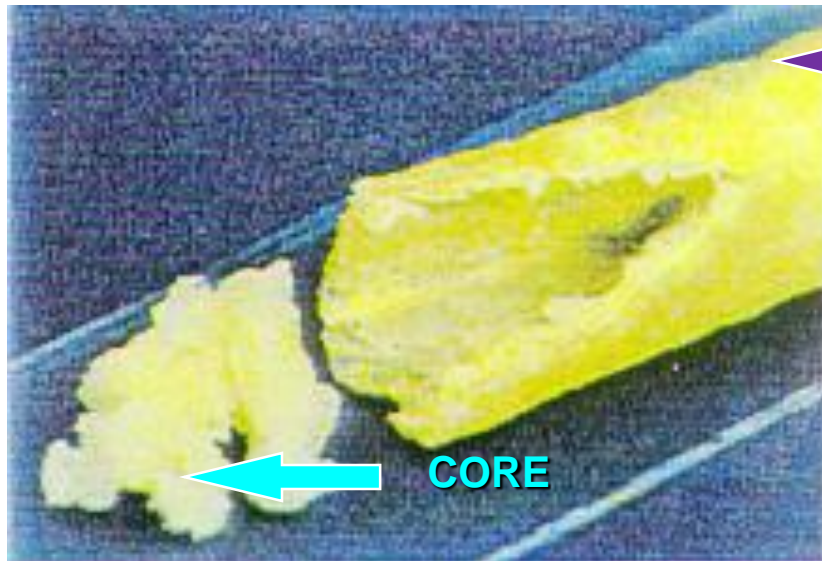
**Raw potato**



**FRYING**



**French fry**



**CRUST**

**CORE**

# CRUCIAL CHANGES IN POTATO TISSUE DURING FRYING

- High heat transfer coefficients: very fast cooking and drastic changes not only in physical properties but also in microstructural properties.
- Development of attractive sensorial properties in processed foods for the consumer: crispness, flavor, color, texture & aroma.
- Maillard Reaction  $\Leftrightarrow$  color, acrylamide, aroma, etc.
- Oil uptake and Acrylamide formation.
- Microstructural changes.

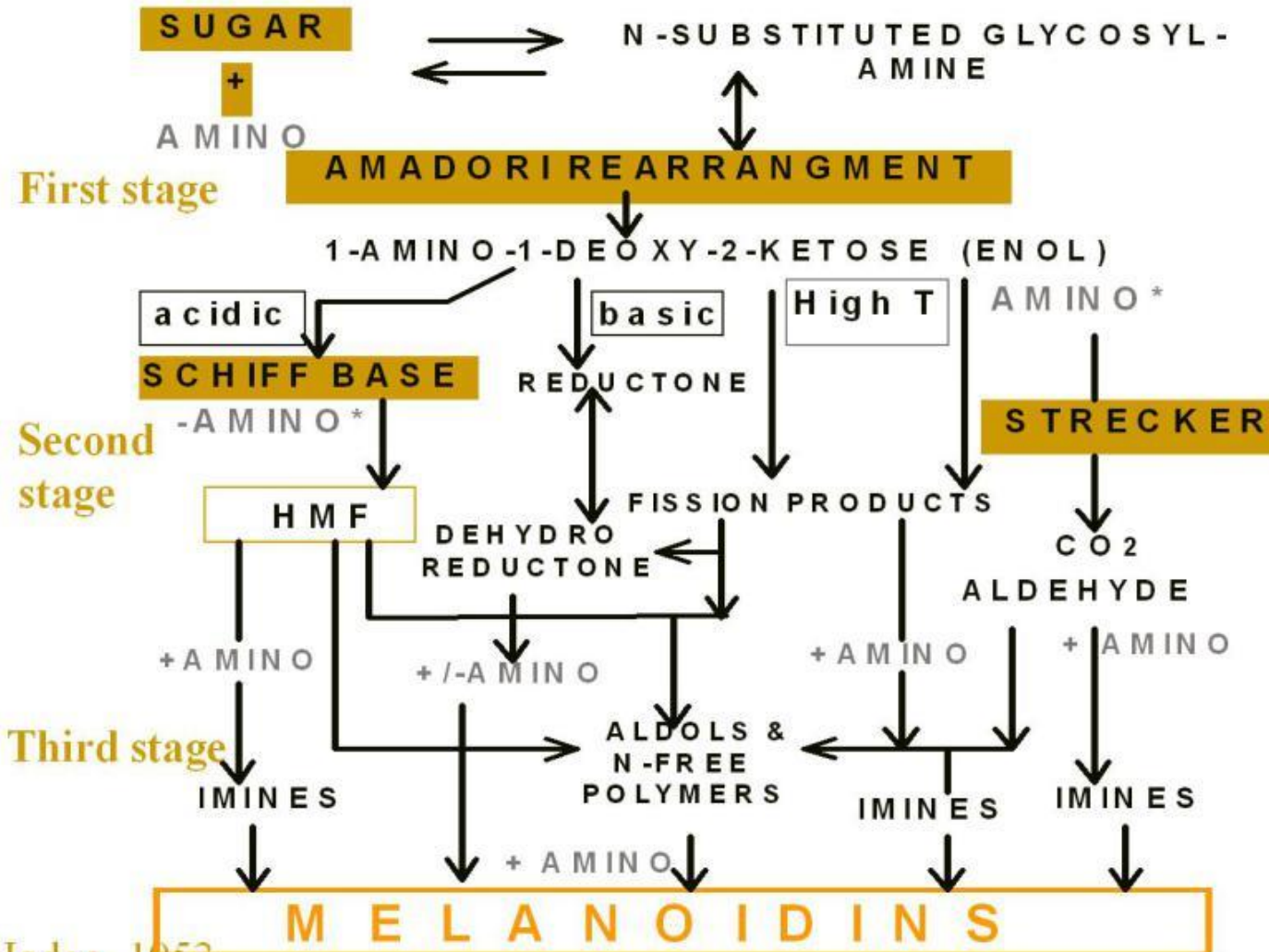
# FOODBORNE RISKS FOR HUMAN HEALTH

- (i) Inherently present in foods (*e.g.* natural toxins, allergens, intolerable compounds, etc.).
- (ii) Related to environmental contaminants (*e.g.* organic persistent contaminants, heavy metals, radionuclides).
- (iii) Related to microbial activity (*e.g.* infectious agents, bacterial toxins, biogenic amines, mycotoxins).
- (iv) Related to animal production practices (*e.g.* antibiotics, hormones, melanine).
- (v) Result of excessively heating during Food processing (*e.g.* acrylamide, furan, heterocyclic amines).

# NUTRITIONAL SAFETY



# MAILLARD REACTION



# NON-ENZYMATIC BROWNING

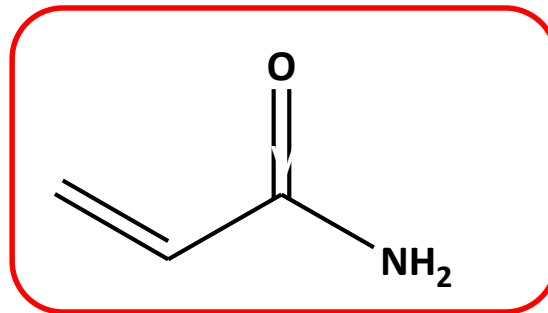




# HEAT PROCESSING IN FOODS

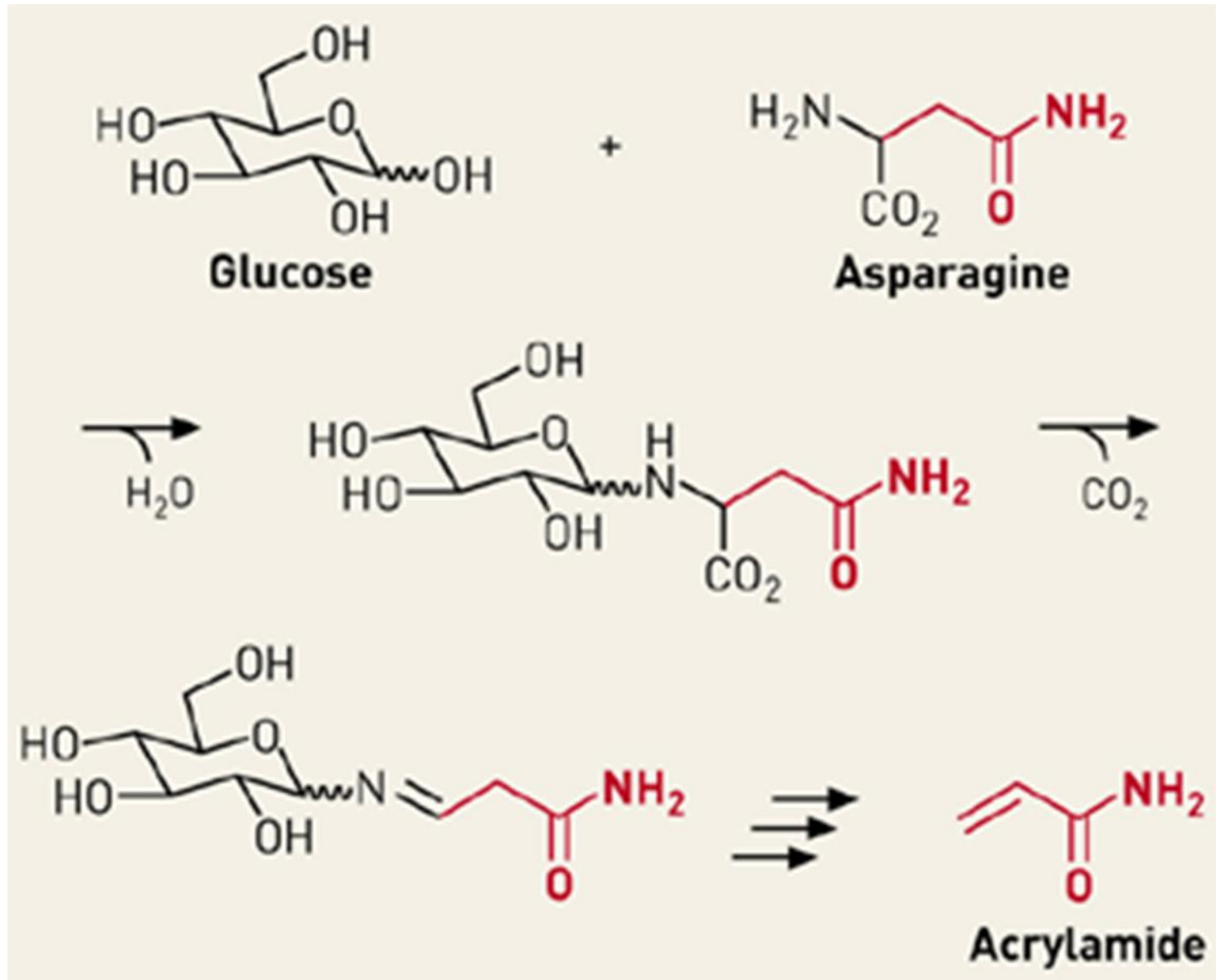


***Excessive heating could increase microbiological safety but at the same time would decrease the chemical safety***



**Acrylamide**

# ACRYLAMIDE FORMATION IN FOODS



# STARCHY FOODS PROCESSED AT HIGH TEMPERATURES



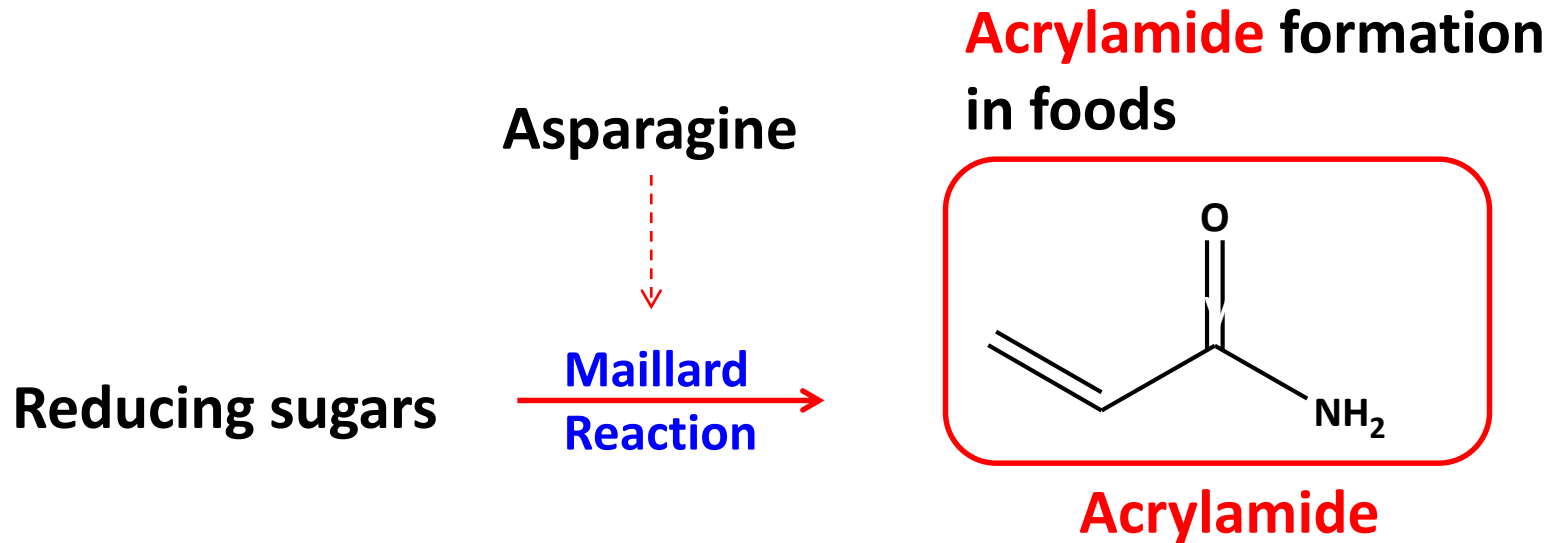
# MOTIVATION

**Acrylamide:** Compound potentially carcinogenic for humans (IARC, 1995)

- **Consumer trends and food preferences**
- **Information necessity**

*It is a challenge to minimize acrylamide levels in starchy foods heated excessively while maintaining as intact as possible the attractive and desired sensorial attributes by the consumers.*

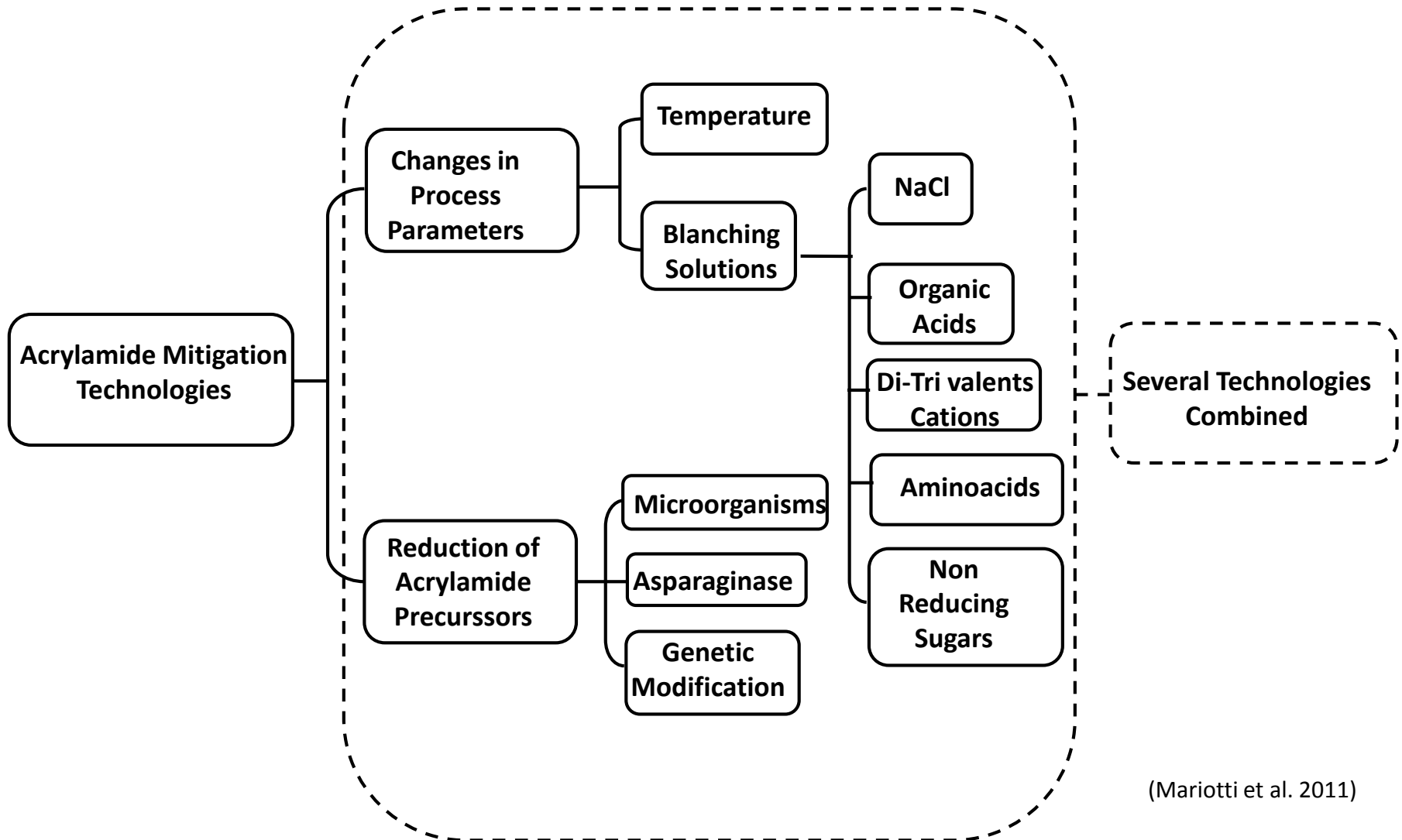
# MAIN ACRYLAMIDE FORMATION MECHANISM



# ACRYLAMIDE LEVELS ( $\mu\text{g kg}^{-1}$ ) IN FOODS

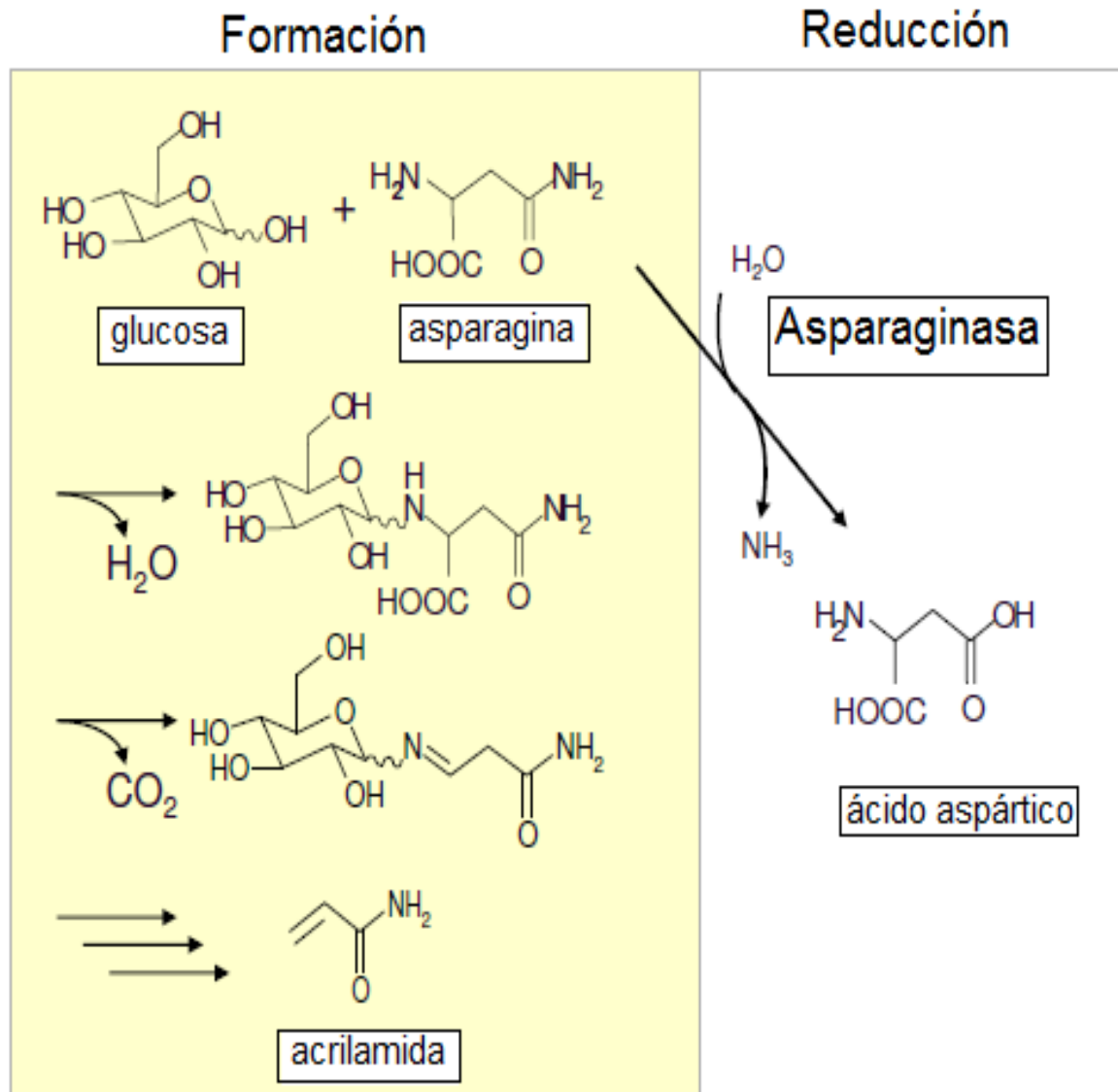
Food	Indicative value ( $\mu\text{g kg}^{-1}$ )	2007			2008			2009			2010		
		No. <sup>a</sup>	Mean <sup>b</sup> ( $\mu\text{g kg}^{-1}$ )	90 perc. ( $\mu\text{g kg}^{-1}$ )	No. <sup>a</sup>	Mean <sup>b</sup> ( $\mu\text{g kg}^{-1}$ )	90 perc. ( $\mu\text{g kg}^{-1}$ )	No. <sup>a</sup>	Mean <sup>b</sup> ( $\mu\text{g kg}^{-1}$ )	90 perc. ( $\mu\text{g/kg}$ )	No. <sup>a</sup>	Mean <sup>b</sup> ( $\mu\text{g kg}^{-1}$ )	90 perc. ( $\mu\text{g kg}^{-1}$ )
<b>Biscuits</b>													
Crackers	500	27	<b>237</b>	755	22	<b>168</b>	365	39	<b>172</b>	504	64	<b>178</b>	303
Gingerbread		458	<b>387</b>	1074	395	<b>355</b>	863	326	<b>359</b>	970	207	<b>415</b>	1187
Infant biscuit/rusk	250	79	<b>174</b>	440	106	<b>94</b>	200	70	<b>88</b>	203	46	<b>86</b>	175
Other biscuits etc.	500	222	<b>309</b>	672	340	<b>196</b>	476	353	<b>180</b>	393	100	<b>289</b>	640
Wafers	500	33	<b>230</b>	478	48	<b>256</b>	645	85	<b>206</b>	491	37	<b>389</b>	880
<b>Bread</b>													
Crisp bread		198	<b>232</b>	480	93	<b>228</b>	590	161	<b>208</b>	400	54	<b>249</b>	665
Bread soft	150	176	<b>75</b>	169	259	<b>53</b>	110	182	<b>46</b>	69	150	<b>30</b>	63
Breakfast cereals	400	144	<b>149</b>	333	166	<b>155</b>	318	191	<b>139</b>	275	174	<b>138</b>	293
Cereal-based baby food	100	65	<b>69</b>	220	69	<b>31</b>	80	55	<b>41</b>	38	82	<b>31</b>	60
<b>Potato products</b>													
Potato crisps	1000	293	<b>551</b>	1200	532	<b>580</b>	1298	414	<b>639</b>	1514	242	<b>675</b>	1538
French fries	600	648	<b>356</b>	742	536	<b>277</b>	570	501	<b>342</b>	640	256	<b>338</b>	725
<b>Homecooked potato products:</b>													
Deep fried		32	<b>395</b>	1140	34	<b>229</b>	588	44	<b>220</b>	549	64	<b>198</b>	568
Not specified		97	<b>272</b>	623	99	<b>213</b>	430	134	<b>253</b>	612	25	<b>270</b>	707
Oven baked		8	<b>365</b>	941	121	<b>256</b>	601	71	<b>333</b>	782	28	<b>690</b>	1888

# MITIGATION TECHNOLOGIES OF AA FORMATION IN FOODS



(Mariotti et al. 2011)

# ASPARAGINASE MITIGATION OF DIETARY ACRYLAMIDE





# IN USA, ACRYLAMIDE POTENTIALLY RIK IN FOODS HAVE BEGUN TO BE REGULATED: CALIFORNIA'S PROPOSITION 65

**“French fries.....contain acrylamide, a chemical known to the State of California to cause cancer”**

The collage displays various nutritional panels from fast-food chains. Key items include:

- My Positive Steps:** A program for tracking daily calorie intake and physical activity.
- Nutritional Information:** Detailed breakdown of calories, total fat, total carbohydrates, and sodium for items like French Fries, Chicken Garden Salad, and French Fries with Cheese Sauce.
- Ingredients:** Lists of ingredients for various menu items, including allergen warnings.
- Allergen Information:** Sections detailing which major allergens (milk, eggs, wheat, soy, peanuts, tree nuts, fish, shellfish) are present in the food.

**WARNING**

Chemicals known to the State of California to cause cancer or birth defects or other reproductive harm may be present in foods or beverages sold or served here. Cooked potatoes that have been browned, such as French fries, hash browns and CHEESY TOTS® potatoes, contain acrylamide, a chemical known to the State of California to cause cancer.

This chemical is not added to our foods but is created when certain foods are browned.

Other foods sold here, such as hamburger buns, biscuits, croissants and coffee, also contain acrylamide, but generally in lower concentrations than fried potatoes. Your personal cancer risk is affected by a wide variety of factors. The FDA has not advised people to stop eating baked or fried potatoes. For more information, see [www.fda.gov](http://www.fda.gov).

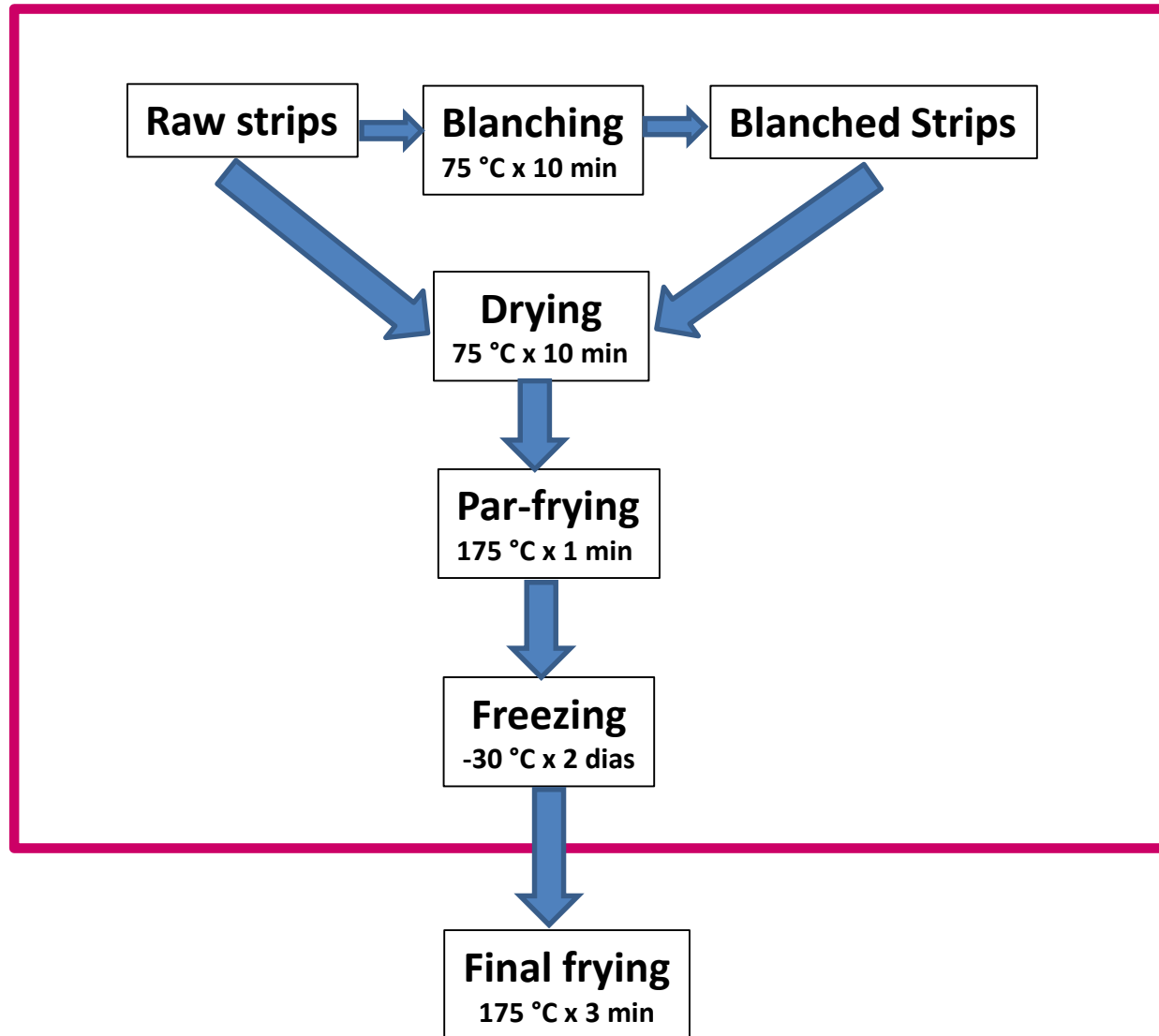
**WARNING**

This product contains acrylamide, a chemical known to the State of California to cause cancer or birth defects or other reproductive harm.

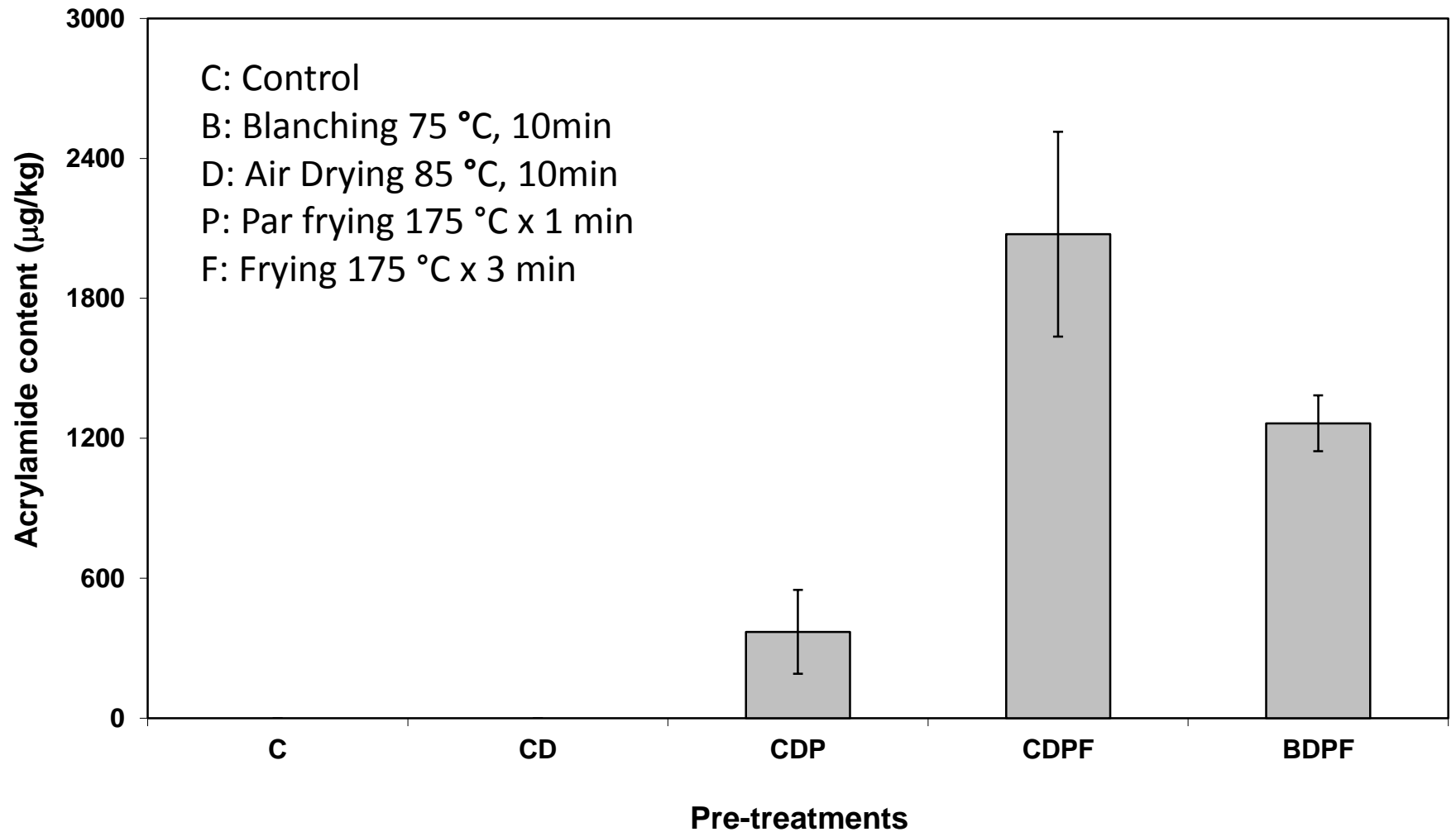
Acrylamide is a chemical that is formed in some starchy foods during cooking. Acrylamide is also found in some tobacco products and in some pesticides.

Other foods sold here, such as hamburger buns, biscuits, croissants and coffee, also contain acrylamide, but generally in lower concentrations than fried potatoes. Your personal cancer risk is affected by a wide variety of factors. The FDA has not advised people to stop eating baked or fried potatoes. For more information, see [www.fda.gov](http://www.fda.gov).

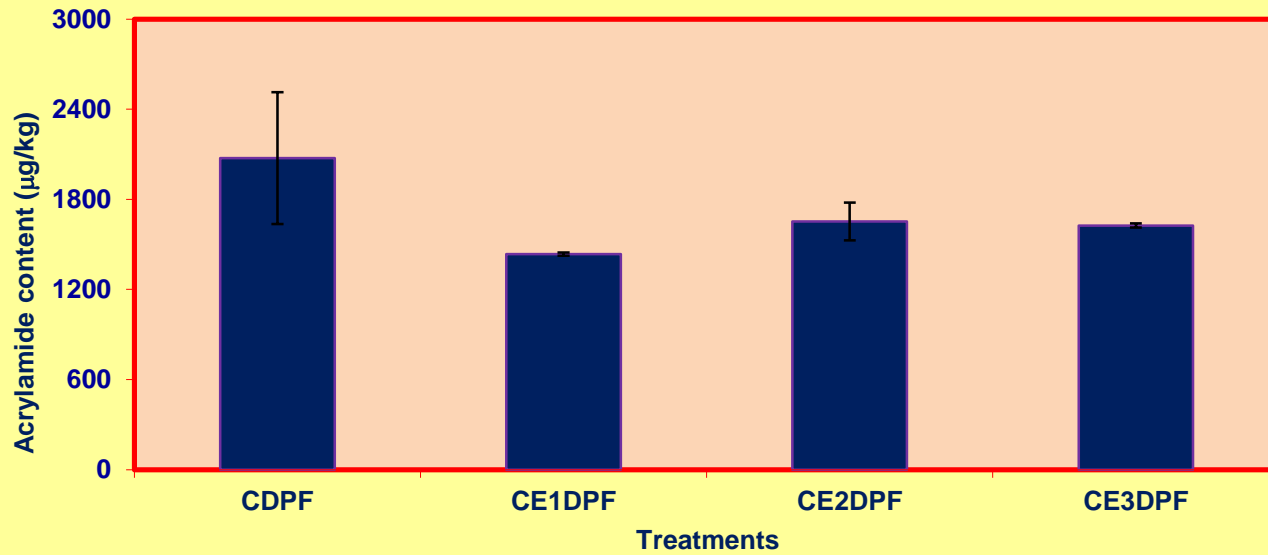
# ELABORATION OF PAR FRIED POTATOES



# ACRYLAMIDE CONTENT IN PAR FRIED AND FINAL FRIED POTATO STRIPS

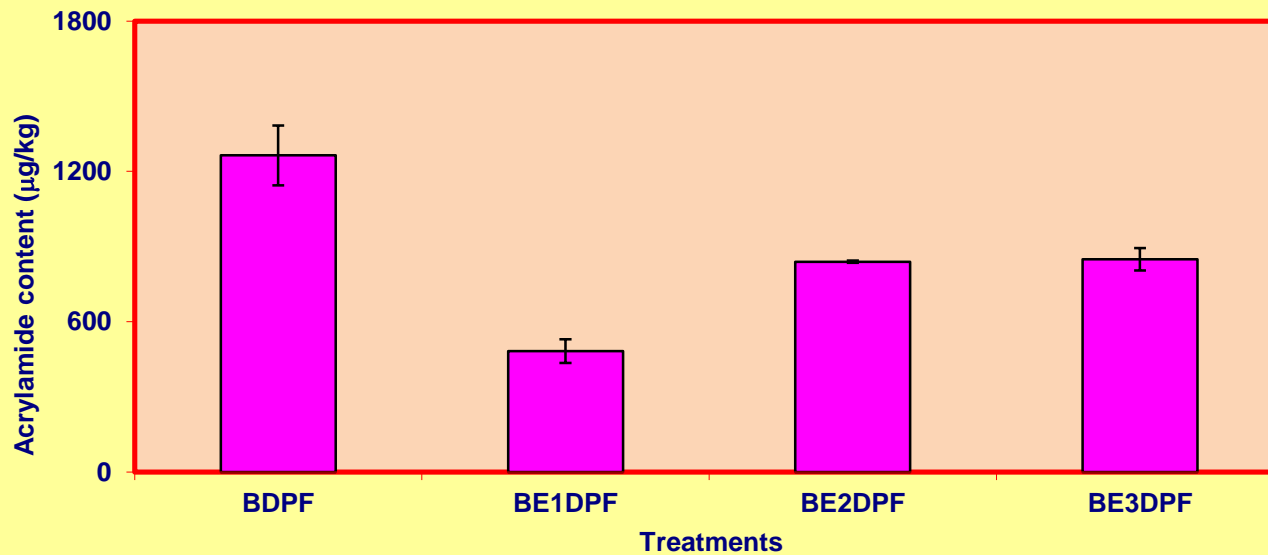


# EFFECT OF ASPARAGINASE IMMERSION OVER ACRYLAMIDE FORMATION IN RAW AND BLANCHED POTATO STRIPS AFTER FRYING

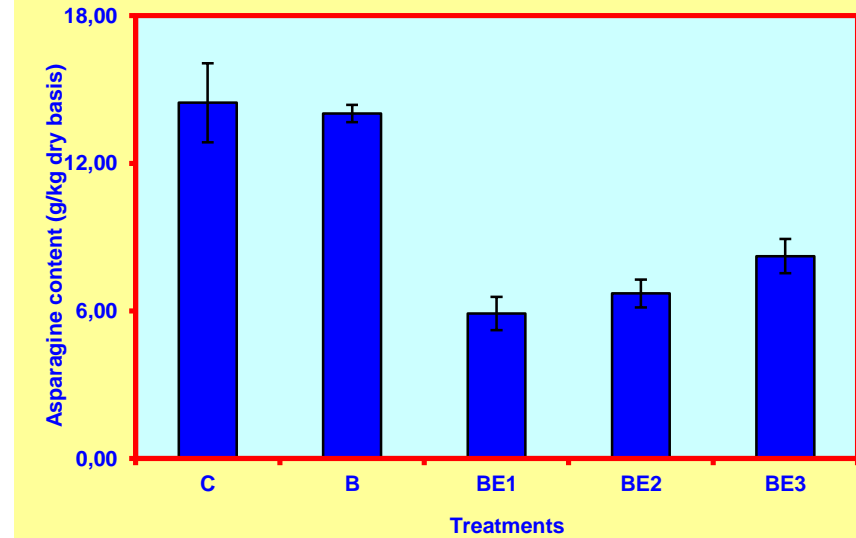
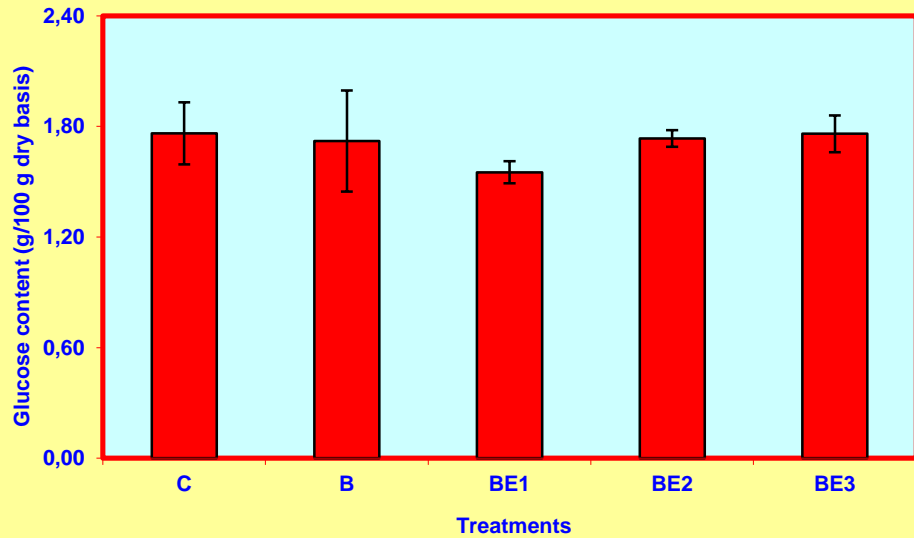
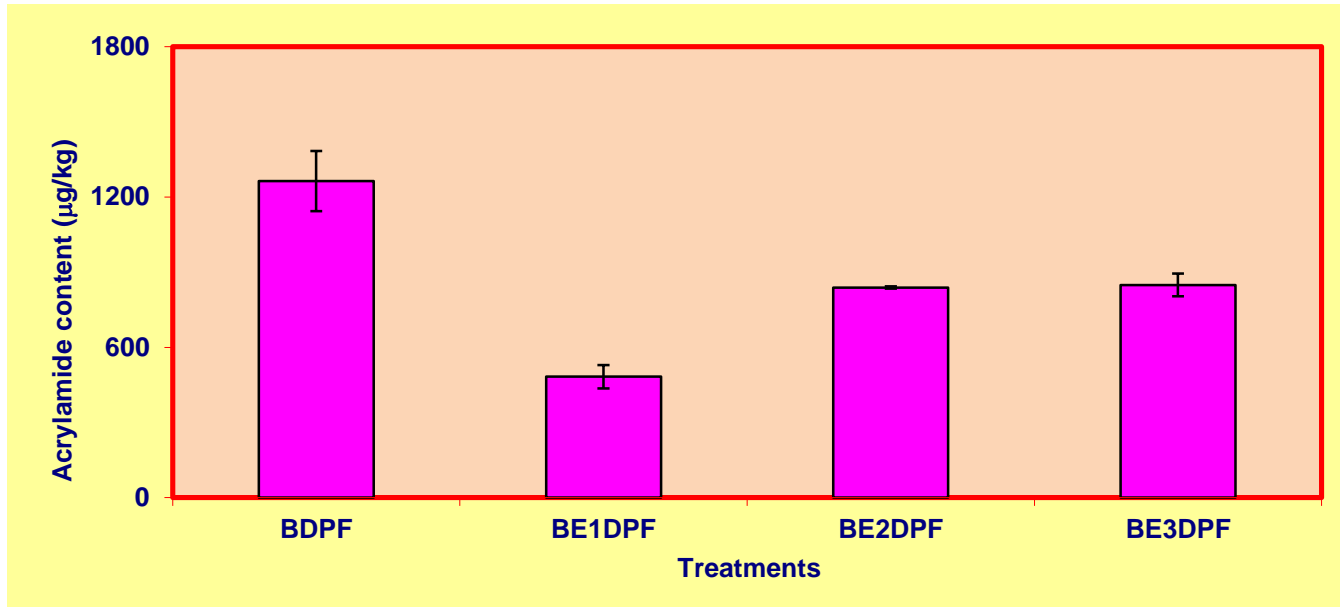


C: Control  
B: Blanching 75 °C, 10min  
E1: Asp 40 °C x 20 min  
E2: Asp 50 °C x 10 min  
E3: Asp 60 °C x 10 min

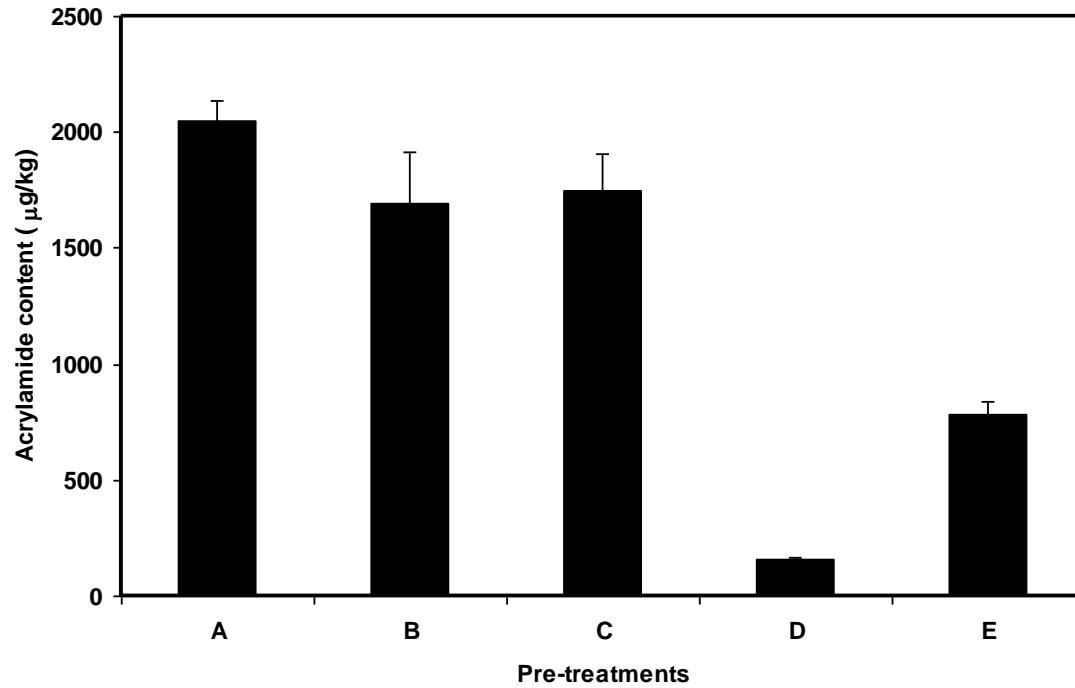
(ASP): 10000 ASNU/l



# EFFECT OF BLANCHING BEFORE ASPARAGINASE IMMERSION OVER ACRYLAMIDE FORMATION IN FRIED POTATO STRIPS

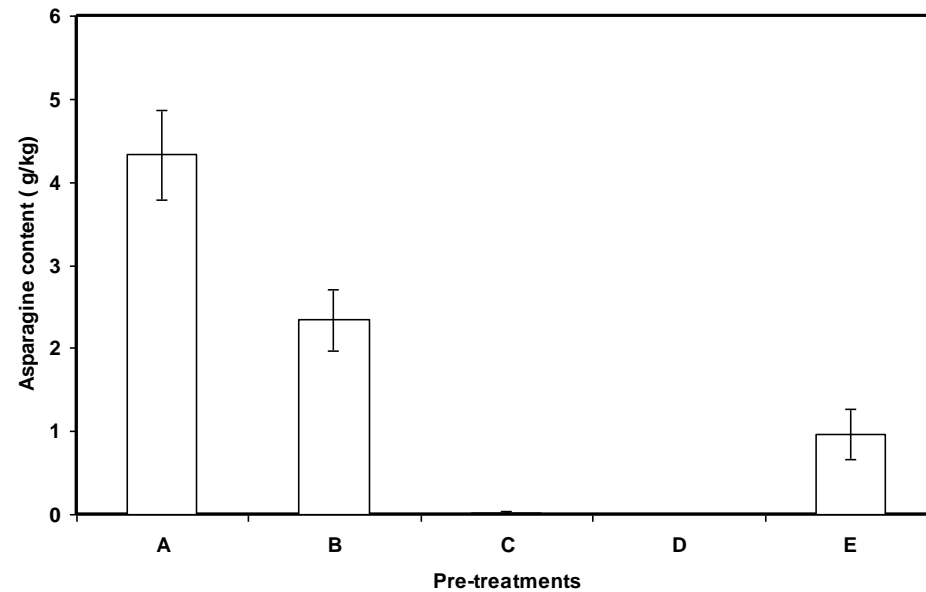
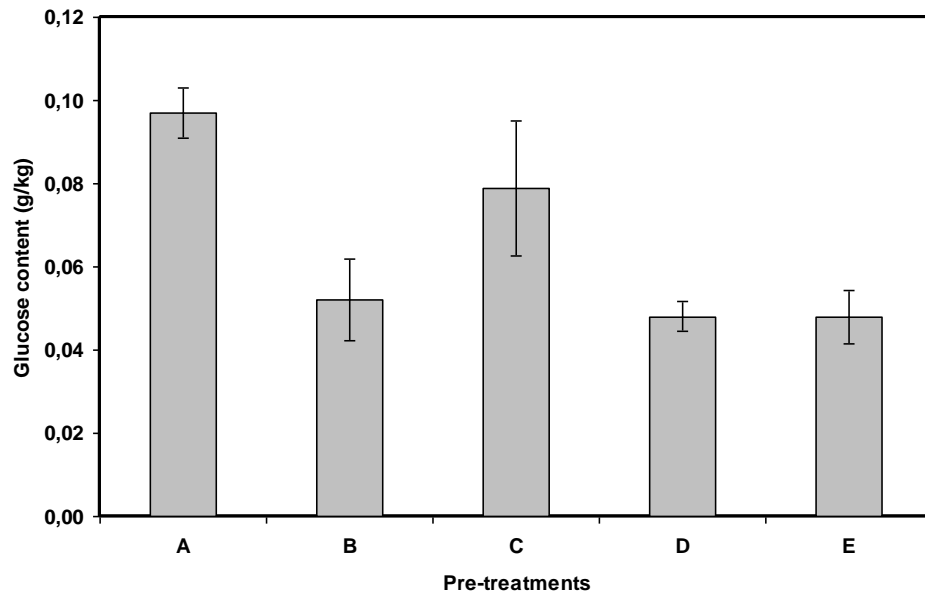


# EFFECT OF BLANCHING BEFORE ASPARAGINASE IMMERSION OVER ACRYLAMIDE FORMATION IN FRIED POTATO CHIPS



A: Control  
B: Blanching 85 °C, 3 .5min  
C: C + Asp 50 °C x 20 min  
D: B + Asp 50 °C x 20 min  
E: B + 50 °C x 20 min

Frying: 1755 °C, 3 min  
(ASP): 10000 ASNU/l



## PAPERS

Acrylamide reduction in potato chips by using commercial asparaginase in combination with conventional blanching. / Pedreschi, Franco; Mariotti, Salomé; Granby, Kit; Risum, Jørgen.  
*Lebensmittel - Wissenschaft und Technologie, Vol. 44, No. 6, 2011, p. 1473-1476.*

The effect of asparaginase on acrylamide formation in French fries. / Pedreschi, F.; Kaack, K.; Granby, Kit.  
*Food Chemistry, Vol. 109, No. 2, 2008, p. 386-392.*

## **CONCLUSIONS**

**Soaking in an asparaginase solution of blanched potato strips was an effective method to diminish acrylamide formation after frying. Asparaginase reduced significantly the amount of asparagine.**

**Blanching improved the action of commercial asparaginase in reducing asparaginase concentration in potato pieces leading to potato chips with lower acrylamide contents.**



# ASPARAGINASE MITIGATION IN CHILEAN BREAD "HALLULLA"



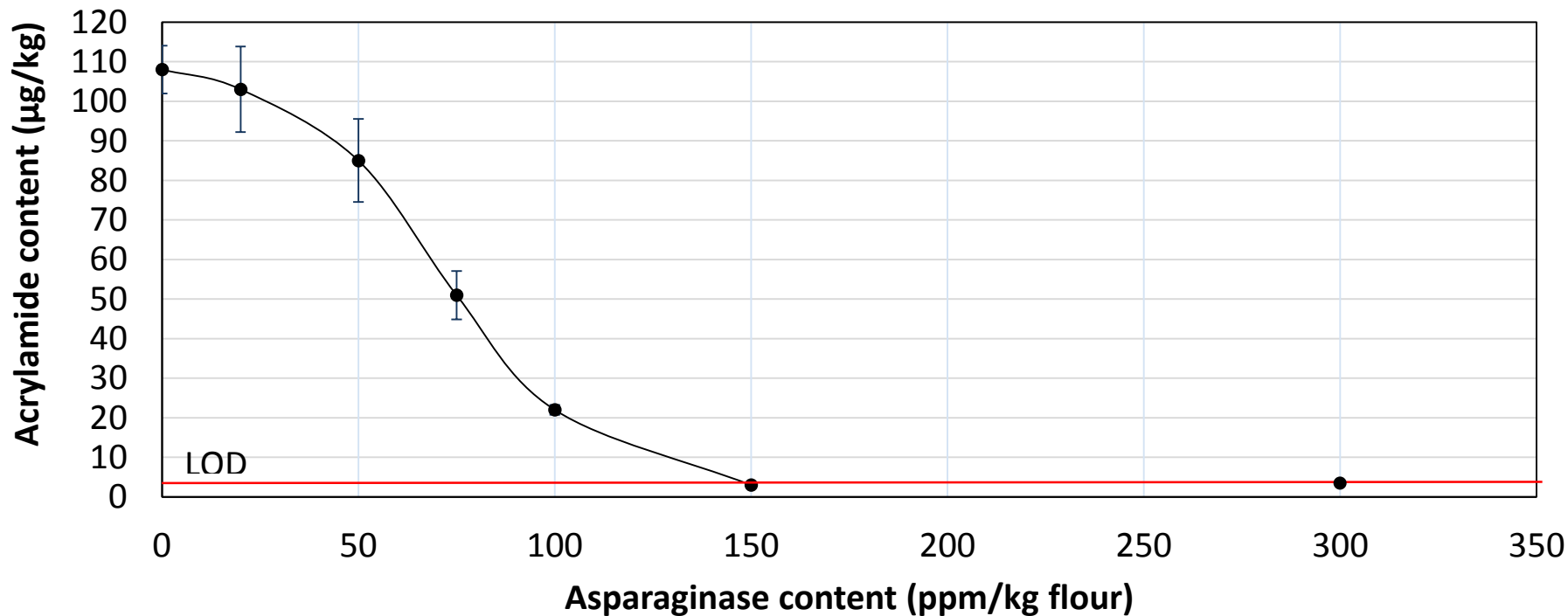
Dough preparation



Baking or cooking



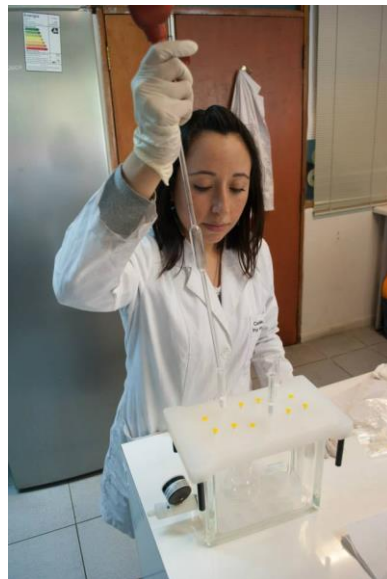
Cooling



# ASPARAGINASE MITIGATION IN SOPAIPILLAS



Addition of L-asparaginase to the dough decreased asparagine levels for all resting times and enzyme concentrations defined in this research (acrylamide decreasing up to ~ 85%).



# **ACKNOWLEDGMENTS**

**Novozymes**

**FONDEF Project D10/110**

**FONDECYT Project 1070031**

**Danish for Food, Agriculture and Fisheries  
Project: Reduction of the formation and  
occurrence of acrylamide in food**