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INTERRUPTED CASE STUDY: WHOLEWHEAT PROMOTION

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Part I - Challenge

Laize is a chemistry student in her final year of college, dividing her time between internship and the university. She has been an intern in Research and Development (R&D) for ten months at BreadFit, a company that manufactures healthy baked goods. Close to the end of her contract, manager Renan calls her for a conversation.

– Laize, first of all, I would like to say that we are thrilled with the performance you have had here at the company. It makes me think about hiring you.

– Good to hear that, Renan. I feel delighted working here at BreadFit.

– However, you know how the economy is going, so to justify a new hiring, the company demands that new employees present some idea that can bring significant benefits.

– But what can I do? I really want to stay here!

– I have a proposal. Our toast line needs to expand; please explore this theme.

Laize thinks fast, remembering her classes on the Maillard reaction, which occurs when the carbonyl group of reducing sugars and the amino group of proteins, peptides or amino acids react at high temperatures, obtaining products that give food flavor, odor and mainly, color; however, they also lead to the formation of acrylamide, which has carcinogenic potential.

– I'm going to develop this line of toast with a lower acrylamide content. With this differential, we entered the international market, which welcomes this concern with acrylamide.

– Excellent idea, hands to work! I'll send some data about our toast line that can help you!

Renan sends some important information, presented in Table 1, that could help the development of the new product.

Table 1. Types of flour, baking times and temperatures.

Types of Flour	Whole Wheat and Rye Flour
Baking Time	22, 26 e 30 minutes
Baking Temperature	180 °C

Classroom activities

1. What do you already know about the case? That is, what have you read about similar situations? What experiences have you had that refer to the subject addressed in the case?

2. Based on the narrative, build hypotheses about the factors influencing acrylamide formation in the toast line and justify their relevance.

3. Based on the narrative, propose a question to be investigated by the group. Attention: the question must consider the context of the narrative, and the possible answers must provide information so that the characters can take action to solve the problem they are facing.

Homework activities

1. Search and select a review text that deals with the subject addressed in the case. Indicate the group's motivation for your choice and what information therein may help in understanding and/or solving the case, justifying the answer.

2. What do you believe would be interesting to know to solve the case in terms of content related to the area of natural sciences and content from other areas of knowledge?

3. Is there additional information about the case context that would allow the group to formulate more precise hypotheses and a more straightforward question?

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Part II – Smell of Bread and Promotion

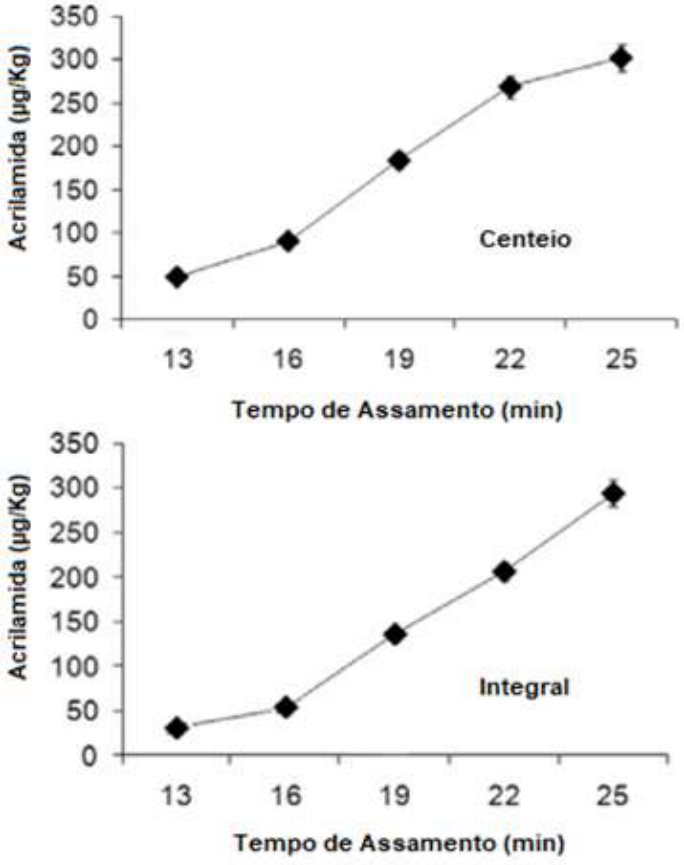
Before devoting himself to investigating the formation of acrylamide in BreadFit toast, Laize takes up the data provided by Renan (Table 1).

Table 1. Types of flour, baking times and temperatures.

Types of Flour	Whole Wheat and Rye Flour
Baking Time	22, 26 e 30 minutes
Baking Temperature	180 °C

Afterward, she prepares several samples of toast and analyzes the formation and concentration of acrylamide during baking. Finally, she quantifies the acrylamide using a previously used procedure at her university. To do so, Laize crushed 2 g of each toasted bread, then performed an extraction with 5 mL of methanol, with agitation for 10 min in a mechanical shaker. After centrifugation, the samples were dissolved in water, prepared by solid phase extraction (SPE), and quantified by LC-MS. The results obtained are shown in Figure 1.

Figure 1. Acrylamide concentration (µg/kg) in BreadFit's Rye and Wholegrain toast, with a baking temperature of 180 °C.



Classroom activities

1. How does the data obtained by Laize help the group to answer the question posed in Part I? Can the hypotheses built in Part I be corroborated or refuted with the new data?

2. Establish relationships between the data presented so far and then elaborate statements that can be provided to the characters in the case to clarify the quality of the BreadFit's toast. The greater the number of statements, with due justification, the more satisfactory the group's response will be.

Homework activities

1. Helping Laize mitigate the concentration of acrylamide in BreadFit's toast is also one of the group's missions. Research at least two ways that can be used to mitigate acrylamide formation and argue for one of them as being the most appropriate. In order to build the group's argument in favor of the chosen method, it is suggested that the following aspects be considered: procedure complexity, cost, amount of sample needed to carry out the analyses, analysis time, organoleptic changes, reproducibility on an industrial and home scale, among others that the group deems interesting.

2. What are the main sectors or groups of society directly affected by acrylamide formation in food? Look for information that corroborates your statements, such as data related to the population's eating habits and the pertinence of using the Maillard reaction in gastronomy.

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Part III – Hiring Now

With previously presented data on acrylamide concentration in BreadFit's toast, Laize is faced with improving the product. After studying, she decided to use glycine and asparaginase as additives in the formulation of breads, as asparaginase can hydrolyze asparagine, one of the precursors of the Maillard reaction. Glycine is intended to compete with asparagine since it is the most reactive amino acid and is more economically viable. However, glycine can negatively interfere with the product's sensory properties, changing the toast's odor.

Laize coordinated the preparation of two types of bread, one with the addition of glycine (1 g/kg of flour) and the other with asparaginase (2,000 U/kg of flour), according to the following procedure: the ingredients were mixed for ten minutes at room temperature in a mixer bowl and the dough manually molded into cylindrical baguettes of about 5 cm in diameter. Then, the breads were baked at 180 °C for 35 minutes. After cooling, the baguettes were cut into 0.5 cm thick slices and toasted at 180 °C. The quantification of acrylamide occurred according to the experimental procedure previously described (SPE/LC-MS).

Classroom activities

1. From the debate that took place between groups that studied the same case study: a) What relationships (similarities, differences, curiosities, among others) are possible to establish between Laize's proposal and the one chosen by your group for mitigating acrylamide in BreadFit's toast? b) What criteria did she use that were not contemplated by your group and vice versa? c) Given what was discussed in the debate, do you think it is appropriate to change the proposed procedure? Argue in favor of the answers.

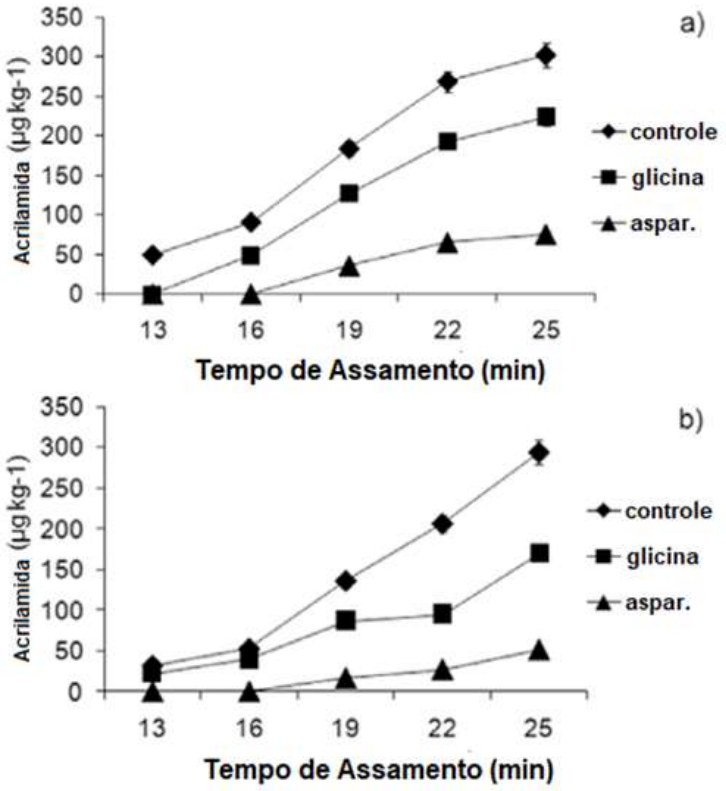
Homework activities

1. Considering the question posed by your group in Part I of the case study, what trends can be predicted for acrylamide analysis after mitigation? Argue in favor of the answers.

Part IV – Warm Toast... Butter Melts!

Based on the experimental procedure indicated in Part III of the case study, Laize found the results shown in Figure 1. Laize decided to use glycine and asparaginase as additives in the bread formulation.

Figure 1.. Effects of adding glycine and asparaginase on acrylamide formation in Rye (a) and Whole Wheat (b) baked at 180 °C at different times. Control: no additives; Glycine: addition of glycine, 1 g/kg of flour; Aspar.: addition of asparaginase, 2000 U/kg of flour.



For a better evaluation of the data presented in Figure 1, Laize searches for international parameters of maximum permitted concentrations of acrylamide in food since Brazilian legislation does not have such reference values. Table 1 shows the reference values she found determined by the European Union to evaluate the acrylamide concentration.

Table 1. Reference levels for the presence of acrylamide in some foodstuffs related to bread.

Foodstuff	Reference Level (µg/kg)
Fresh wheat-based bread	50
Fresh bread, excluding wheat-based bread	100
Products similar to biscuits and breads, except for those based on potatoes	300

Source: European Union (2017)

EUROPEAN UNION. Jornal Oficial da União Europeia, v. 304, p. 24-44, 2017.

Classroom activities

1. Establish relationships between the data presented in Figure 1 and then elaborate statements that can be provided to Laizw to help them in her purpose, mentioned in Part II of the case. The greater the number of statements and recommendations, with due justification, the more satisfactory the group's response will be.

2. Compare the acrylamide concentration values obtained by Laize, illustrated in Figure 1, with the maximum concentrations allowed in the legislation, mentioned in Table 1, and present conclusions about it.

3. What can you say about the trends you explained in the exercise in Part III for analyzing acrylamide after mitigation? Justify the answer.

Homework activities

1. Construct and complete the summary table below, which summarizes the actions and results obtained in all stages of the study.

Problem situation: This item presents the existing problem in the case. That is, it is necessary to briefly describe the narrative and the problem that afflicts the main characters.
Problem: This item presents the problem/issue to be resolved. As every problem must start with a question, the statement must be formulated in such a way as to end with a question mark.
Hypotheses: This item presents the hypotheses formulated to solve the problem. Hypotheses are assumptions issued as preliminary answers to the problem at hand. The same problem can have many hypotheses, which are possible solutions for its resolution. In this perspective, indicate your basic hypothesis, which is the explanation you have chosen as being the main one for the proposed problem. Then, indicate the secondary hypotheses, which are complementary statements and/or other possible answers to the problem. These can cover in detail what the basic hypothesis states in general and aspects not specified in the basic hypothesis.
Mitigation planning: This item describes the steps and resources you used to propose a mitigation route to evaluate your hypotheses. Add pictures to make your answers more straightforward. Finally, conclude the answer by pointing out whether you changed the initial planning when confronted with the planning presented by the case characters or colleagues in Part III (Debate).
Data: This item presents empirical data or data from other sources (including data provided during classes) with which you worked that allowed you to evaluate your hypotheses and the range of responses to the problem. Add pictures to make the answer more straightforward.
Conclusions: This item presents the final conclusion of the group regarding the problem explained in the case and all the other conclusions reached during the resolution of the case.
Justifications: This item presents the justifications that support the explicit final conclusion and those that support the partial conclusions mentioned above. Try to gather the largest number of justifications and present them so that they are supported by available data (in this case, add images to make the answer more straightforward) and knowledge reported in the literature.