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RESEARCH ARTICLE

REVISED Nutritional and sensorial analysis of a lentil flour-based sweet pancake premix

[version 2; peer review: 7 approved with reservations, 1 not approved]

Carla S. Santos, Marta W. Vasconcelos

CBQF - Centro de Biotecnologia e Química Fina, Escola Superior de Biotecnologia da Universidade Católica Portuguesa, Porto, 4169-005 Porto, Portugal

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Abstract

Background

Legume flours have been a target for ingredient innovation in the last decade. Legume grains have high protein and fibre content and are gluten-free, making them suitable for different consumer types, including celiac patients. Additionally, legume grain cultivation reduces synthetic fertiliser application, providing environmental benefits and improving ecosystem functions.

Methods

In this study, a commercial pancake flour mix where part of cereal flour was replaced with lentil flour was developed. The nutritional value was analysed and a quantitative blind affective test was performed to understand the consumer acceptability of the lentil-based pancakes. A questionnaire was developed to survey consumers preferences towards pancake consumption and purchase factors.

Results

When compared to the commercial counterpart, the lentil-based pancakes had higher protein and lower carbohydrate and salt contents. Of the 90 non-trained panellists (72 women, 18 men; aged between 18 and 56), only 6% were consumers of pre-made pancake dry mixes. The panel attributed superior ratings in texture, flavour and global appreciation scales to the lentil-based pancakes and 63% of the participants responded they probably/certainly would buy the lentil flour pancakes if commercially available.

Open Peer Review

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Conclusions

It is possible to partially replace cereal flour with lentil flour in sweet pancake preparation, delivering a gluten-free product with an improved overall nutritional profile, and appealing to a broad range of consumer needs.

Keywords
climate change; gluten-free; health claims; plant-based; pulse crops; snacks; sensorial tests; sweet foods



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Corresponding author: Marta W. Vasconcelos (mvasconcelos@ucp.pt)

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REVISED **Amendments from Version 1**

Since the previous version of the manuscript, significant changes have been made to improve the overall quality of the study. The introduction was expanded to clarify the novelty of the work, emphasizing the unique combination of oat and lentil flours in a vegan, gluten-free pancake recipe. Unlike prior studies, which incorporated other legume flours alongside animal-based ingredients, this study focused on creating a plant-based alternative. Additional references were included to contextualize the research and better articulate the gap it addresses, alongside a clear statement of the hypothesis guiding the work.

The methods section was revised to provide greater detail about ingredient sourcing, storage, and preparation. Specifics were added about how both recipes were made, including the use of a pancake maker to standardize preparation. Sensory evaluation details were clarified, specifying that pancakes were served warm with an optional chocolate topping, and information about participant recruitment and ethical approval was included.

In the results and discussion, language was refined to avoid overstating the findings. Limitations were acknowledged regarding the lack of analysis of physical and technological properties, such as texture, volume, and colour. The implications of the study's findings were discussed in light of consumer preferences, noting that despite the limited popularity of pancakes in Portugal, the lentil-based recipe showed potential for appealing to health-conscious and gluten-free consumers. Updates were made to address consistency and clarity throughout the manuscript.

Any further responses from the reviewers can be found at the end of the article

Introduction

The growing food demand and the consequent pressure on natural resources have led to the need for modern societies to develop strategies for a more sustainable and socio-environmental-conscious lifestyle[1]. There is a global consensus on the need to reduce the consumption of animal protein[2] and to develop alternative products of plant origin with a nutritious and sustainable profile.

However, food production remains one of the sectors with a higher carbon footprint[3] and, to sustain the expected increase in production to support global food security, it is necessary to promote sustainable agricultural practices that imply less use of water, fossil fuels, and agrochemicals. Legume grains, as a protein source, have a more positive outcome on greenhouse gas balances and carbon footprint[4] than animal protein, and their wider inclusion in agricultural systems can help in climate change mitigation[5]. They are natural soil fertilizers, reducing the use of synthetic nitrogen fertilizers; they contribute to breaking pest life cycles, resulting in a reduction in the use of phytochemicals; and they promote soil microbial diversity, improving soil quality[6]. Given these attributes, legumes production, utilisation, and consumption largely contribute to achieving the Sustainable Development Goals (SDG) 12 on responsible production and consumption, and 13 on climate action (https://sdgs.un.org/goals).

However, the technology associated with legume grain cultivation has been delayed and the incentive in the agricultural sector for their exploitation is still not enough. To overcome this 'lock-in', the importance of including and increasing the production/use of pulses has been highlighted in recent policy debates on global food security[7]. The Food and Agriculture Organization of the United Nations declared the year 2016 as the International Year of Pulses, to make both the food industry and consumers aware of the need to adhere to more sustainable practices[8]. In 2018, the European Commission issued directives to increase the production of legume grains as one of the key solutions to a sustainable future[9]. Currently, the new Farm to Fork Strategy for 2030 aims at achieving sustainable food systems and healthier diets, to combat biodiversity loss, tackle climate change and ensure food affordability[10]. These are goals that can be supported by increased legume grain production and consumption.

Generally, legume grains have high protein and fibre content and low glycaemic index[11], and the bioactive compounds in their composition have been associated with the reduction of cardiovascular risk factors and metabolic health improvement[12]. Additionally, the increasing prevalence of celiac disease and gluten intolerance underscores the need for innovative gluten-free food products that meet nutritional and sensory expectations[13]. Celiac disease affects approximately 1% of the global population[14], with many others adopting gluten-free diets due to gluten sensitivity or perceived health benefits. However, many gluten-free products currently available on the market lack essential nutrients, particularly fibre and protein, and often have inferior sensory qualities compared to their gluten-containing counterparts[15]. This has led to a growing demand for gluten-free alternatives that are not only safe for celiac patients but also nutritionally balanced and enjoyable to consume[13].

Legumes are also affordable sources of essential micronutrients, contributing to achieving food security and improved nutrition, thus contributing to SDG2[16]. Hence, the use of legumes as a plant-based protein source is increasingly in the spotlight, especially because their rich nutritional profile and functional properties are maintained when processed as flour, and even after heat treatment[17]. Concomitantly to improved awareness of healthy diets and sustainability, the number of legume-based alternatives being launched to the market has been increasing[18]. The legume grain-based snacking industry is a particularly growing market[19], as convenience is one of the main drivers underlying consumer behaviour and preferences[20,21]. The main processing methods for snack production are extrusion, frying and baking[19] and some examples of legume flour-based sweet baked products include chickpea flour muffins[22], bean flour cupcakes[23] and faba bean flour cookies[24]. Sweet baked products and snacks can be particularly attractive to children and adolescents, but these are usually characterised by a profile rich in energy and poor in nutrients, with high sugar and salt content[25–27]. The World Health Organization (WHO)

has issued a policy statement recommending an urgent reduction in sugar intake[28], and also WHO Member States have agreed to reduce the global population's intake of salt by a relative 30% by 2025[29]. Hence, in the last decade, the snacking industry has been pushed not only by policy directives but also by changing consumer preferences to adapt to healthier profiles. Collectively, these recommendations should be taken into consideration in food product innovation.

Among the vast diversity of existing legumes, lentils (*Lens culinaris*) have a fast preparation time, low phytic acid content and high folate and total phenolic content of antioxidant flavonoids[30]. The use of lentil flour in product development offers great potential due to its mild taste and its protein fraction, which has physicochemical and functional properties that allow product development with good sensory attributes[31,32] and lower environmental impact, when compared to cereal-based counterparts[33]. Hence, different types of products have been developed using lentil flour, such as bread, crackers, pasta, yogurt, soups, or meat alternatives[34–38].

Pancakes are one of the most popular snacks worldwide, usually consumed at breakfast, and are composed of high carbohydrate content and low fibre content[39]. Replacing the ingredients of traditional recipes, usually cereal-based, with bio-functional alternatives has been shown to improve the nutritional profile of different food products[19], as well as their environmental impact[40]. Inclusively, a few studies have demonstrated that including up to 10% to 20% of legume flours in sweet pancake recipes improves the nutritional profile, without affecting the sensory quality[41–43]. However, these recipes include gluten, eggs and/or milk, not being suitable to all types of consumers.

The main hypothesis of this study was if partially replacing cereal flour with lentil flour in a sweet pancake mix would improve the nutritional profile (higher protein and fiber content, lower sodium and carbohydrate content) while maintaining or enhancing the sensory properties (appearance, texture, and flavour) compared to a commercial pancake mix.

Methods

Ethical statement

All study procedures were accomplished in full compliance with the Declaration of Helsinki on ethical principles for medical research involving humans and received approval from by the Institute of Bioethics of the Portuguese Catholic University (Ethics Screening Report 11/2017).

Upon receiving the invitation to participate in the study, the volunteers completed the written informed consent form that presented the objectives and procedures of the study. After the completion of the research, the files will be kept for five years, in case it is necessary to legitimize any information, and after this period, they will be destroyed.

Lentil-based pancake formulation

The formulation comprised, per 100 g of dry mix, 55 g of oat flour (Próvida, Portugal), 26.2 g of red lentil flour (Amisa, Portugal), 13.1 g of coconut sugar (Iswari, Portugal), 3.1 g of baking powder (Royal, Portugal), 2.1 g of baking soda (Margão, Portugal) and 0.5 g of powdered vanilla aroma (Vahiné, Portugal).

To each 100 g of lentil-based pancake mix, 125 mL of water and 7 mL of vegetable oil (Fula, Portugal) were added. The batter was divided in five portions and pancakes were prepared by frying in a non-stick pan. The commercially available product used as counterpart in the study was the 'Easy Mix Pancakes' from Muuglu brand (Spain), composed of rice flour, 37% of oat flour, whole cane sugar, cinnamon, salt, sodium bicarbonate and citric acid. Pancakes were prepared according to the manufacturer's instructions.

Lentil-based pancakes nutritional evaluation

Lentil-based pancakes were prepared as described in Lentil-based pancakes formulation, with three replicates. The whole formulation was analysed for its nutritional content. Energy content was calculated following the EU regulation 1169/2011[44]. Crude fat content was determined by acid digestion in 25% HCl and subsequent Soxhlet ex-traction with petroleum ether. The Kjeldahl method (ISO 1871:2009) was used to analyse total protein content, with the 6.25 conversion factor[45]. The enzymatic-gravimetric method from the AOAC 991.43 and AOAC 985.29 was used for determining the total fibre content[46,47]. Random replicates were performed to 7% of the analysis by a credited laboratory that follows standard, verified, and certificated protocols, and that regularly works with industry.

Participant recruitment

The study was conducted in the city of Porto (Portugal), and overall data collection, participants' assessments and dietary interventions took place at the Faculty of Biotechnology of the Portuguese Catholic University (ESB-UCP). Volunteers were recruited at ESB-UCP, as well as at the university campus neighbouring areas, via common communication channels, such as e-mail networks, social media, flyer distribution, poster affixation and word-of-mouth. Subjects were screened according to general eligibility criteria: male or female individuals older than 18 years old; healthy, with no severe food allergies or food intolerances; with no severe chronic inflammatory, infectious, endocrine, or metabolic diseases, including gastrointestinal disorders; not pregnant or breastfeeding. The study involved 90 untrained participants (72 women, 18 men) aged between 18 and 56 (mean = 29.1, standard deviation = 9.7).

Sensory analysis

A quantitative blind affective test was performed on the 27th of March of 2018. No ingredient information was provided to the participant, allowing to establish a baseline preference rating in comparison with a similar commercially available product. Samples were encoded using three-digit numbers and presented simultaneously but in randomized order per participant. The lentil-based pancakes were compared with an existing product and a nine-point hedonic scale was used to indicate the degrees of acceptance from '1 = dislike extremely' to '9 = like extremely' of appearance, texture, flavour and

overall appreciation. Both pancakes were served warm and a chocolate topping was provided to the participants.

The sensorial analysis questionnaire included full information explaining the purpose of the experiment and the procedure followed, to be read prior to taking part in the experiment, together with an informed consent form. Questionnaires were developed according to methodologies previously established at ESB's Sensorial Platform and were distributed in Portuguese.

The participants were asked to rate from '1 = completely disagree' to '5 = completely agree' the importance of different factors when purchasing food products. The questionnaire also included questions regarding the willingness to consume the pancakes if available at the market. A blank copy is provided as extended data[48].

Statistical analysis

Mean comparisons on an error probability level of $P < 0.05$ were calculated using unpaired t-test on GraphPad Prism 8 version 8.4 for macOS X (GraphPad Software, La Jolla, CA, USA).

Results

Nutritional analysis

The composition of the cooked lentil-based pancake mix developed in this work (Figure 1) was obtained by laboratory nutritional analysis. The nutritional value of the commercial pancake mix was taken from the information available on the brand's website (Table 1).

The energy content of the two products was similar, with 211 kcal per 100 g of lentil-based pancakes versus 208 kcal per 100 g of commercial pancakes. The carbohydrate content was lower in the lentil-based mix, with a total of 34.4 g per 100g.

Regarding protein content, the lentil flour pancakes had 1.4 times more protein than the commercial formulation, corresponding to 14.2 % of the product's total energy value (Table 1).



Figure 1. Dry mix for lentil-based, sweet pancakes preparation.

Table 1. Energy, total fat, carbohydrates, protein, total fibre and salt content of 100 g of lentil-based and commercial pancakes, prepared according to the instructions.

Nutritional composition	Lentil pancakes	Commercial pancakes[1]
Energy (kcal)	211	208
Total fat (g)	5.8	3.8
Carbohydrates (g)	34.4	36.5
Protein (g)	7.5	5.2
Fibre (g)	4.3	n.a.*
Sodium (mg)	100	400

* not available

Although no information on the fibre amount of the commercial pancake mix is provided, the lentil flour pancakes had a total of 4.3 g of fibre per 100 g of product. The sodium content in lentil flour pancakes was four times lower when compared to the commercial formulation (Table 1).

Sensory analysis

Of the 90 participants in the study, 71% were regular consumers of pancakes. Participants also responded to the most frequent form of pancake consumption: 71% prepared them at home, using the individual ingredients; 47% consumed pancakes only at restaurants, and only 6% used premade dry pancake mix for preparation at home[49].

The importance given to different factors when purchasing this type of product was evaluated (Figure 2). The participants identified as the most important factors that the product should have good flavour, good texture, and an easy and quick preparation method. The least important factors were to be low in calories, rich in protein, and have low-fat content.

The mean scores of sensory characteristics for lentil flour pancakes and the commercial formulation are shown in Figure 3. The results for the appearance attribute were similar in both products (median = 7). Texture and flavour had significantly higher scores in lentil flour pancakes (Figure 1), 28 % ($P < 0.0001$) and 22 % ($P < 0.001$), respectively.

The overall acceptance of both products had statistically significant differences, where the median of the commercial formulation was 6 and of the lentil flour pancakes was 7 (Figure 2). The lentil flour pancakes had a significantly 15% higher score on overall appreciation than the commercial formulation ($P < 0.01$).

[1] Information retrieved from the fabricant website

Willingness to consume influencing factors

The participants of the study were asked about their willingness to consume the product if available at the market, with a convenient price and preparation method (Table 2). The majority of the participants responded with '4 = probably would consume' for the lentil flour pancakes, while for the commercial formulation, most respondents answered with '3 = I have doubts if I would consume or not'.

Discussion

Conventional snacks, especially those targeted at younger consumers, are usually associated with high fat intake[25]. Here, total fat was 1.5 times higher in the lentil-based pancakes when compared to the commercial formulation (Table 1). However, high-fat products usually contain 13 g or more of total fat per 100 g of product[50]; here, 100 g of lentil-based pancakes had 5.8 g of fat, corresponding to 7.4 % of fat daily intake of adults and children. The recommended portion of each pancake is 20 g and, although this formulation cannot be considered low in fat (low-fat foods must have less than 3 g of fat per 100 g of product), it has a moderate amount of fat[51]. Moreover, the lentil flour pancakes can be considered as a source of protein[51]. The addition of legume grain flours to baked products has oftentimes the main goal of increasing protein content[20] although, in the case of lentil flour, it may also impact structural properties and protein digestibility[52]. Current animal-based protein intake among European adults is twice the global average, being important to promote alternative protein sources, with lower health and environmental impact[12,53]. This pancake-ready mix provides a balanced protein amount and nutritional profile and can be incorporated as a healthy and sustainable food choice. The developed product can also be considered high in fibre, as it meets the recommendations made by the EU standards[51] which require a minimum of 6 g of fibre per 100 g of sample for high fibre claim in food products. The intake of fibre is usually associated with several diseases' prevention, such as type 2 diabetes, heart disease, and certain types of cancers, and modulates gut microbiota[53]. As traditional pancake recipes have low fibre content[54], the addition of lentil flour to this formulation leads to a nutritional and functional change in the final product that may have a positive effect on consumers' purchasing options. According to Regulation (EC) No 1924/2006, products with morels than 0.12 g of sodium per 100 g of product are considered 'low sodium'. Salt is frequently added to baked goods, as it significantly affects flavour and texture, often resulting in 'hidden-salt' consumption[55]. The rich mineral content of lentils may help reduce sodium content while maintaining pleasant sensory properties, which may be attractive to hypertensive and health-conscious consumers. Furthermore, the use of oat and lentil flours, both gluten-free, makes this product relevant not only to individuals with celiac disease (about 1% of the world's population) but also to the growing number of consumers that are adopting gluten-free diets[56].

In the present study, only a small percentage of panellists declared that generally consumes store-bought dry pancake mix. This may be representative of the fact that, in Portugal, pancake consumption is a relatively recent trend and not widely adopted. On the contrary, according to U.S. Census data and Simmons National Consumer Survey (NHCS), circa

Table 2. Willingness to consume the products if available at the market, from '1 = certainly would not consume the product' to '5 = certainly would consume the product'.

	Lentil pancakes	Commercial pancakes
Mean	3.77	3.11
SD	1.01	1.29
P-value	0.0002	

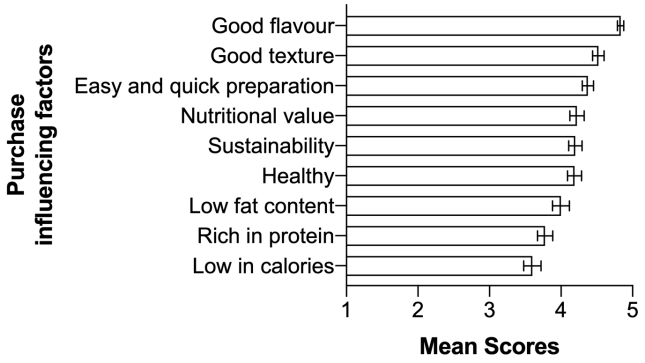

Figure 2. Mean scores attributed to different purchase influencing factors regarding pre-made pancake dry formulations from '1 = completely disagree' to '5 = completely agree'. Data are means and SE of 90 ratings.

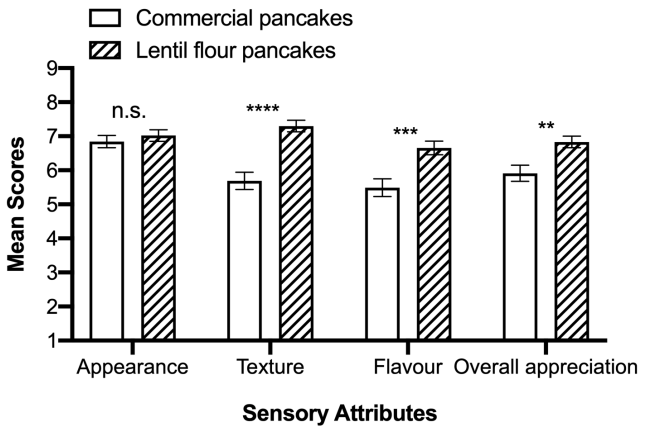

Figure 3. Sensorial analysis mean scores attributed to appearance, texture, flavour and overall appreciation of lentil flour pancakes vs. commercial formulation. The assessment was based on an anchored nine-point hedonic scale, from 1 = dislike extremely to 9 = like extremely. Data are means and SE of 90 ratings. Significant differences between pancake formulations are indicated at ** P < 0.01, *** P < 0.001 and **** P < 0.0001.

207 million Americans used store-bought dry pancake and waffle mixes in 2020[57]. This is an important market worldwide, especially gluten-free mixes, that fulfil not only convenience but also health-related demands[58].

Regarding the purchasing factors for this type of product, characteristics related to the product sensory attributes and convenience had an increased level of importance, while nutrition factors had the lowest. Additionally, given the positive impact of legume-based foods on the environment, it is important to note that 'sustainability' was ranked in the 5th position of the purchase influencing factors listed in the sensorial analysis questionnaire (Figure 2). This result is in agreement with recent studies that show that the 'environmentally sustainable' factor is yet to be on the top of the motivation factors for consumers in Europe to change dietary habits[59].

In terms of the impact of the addition of lentil flour to baked products, some studies report that it may lead to a darker colour and higher density in the products (e.g., bread)[52], and a substitution level of wheat flour by lentil flour at 10% was considered optimum to avoid negative sensorial attributes[34]. A proportion of 26% of lentil flour was used in the lentil-pancake formulation, without a negative impact on appearance, texture, or flavour. This shows that this type of sweet baked product may be a good vehicle to introduce pulses in general diets and that can be attractive to younger consumers. Overall acceptance scores of different sweet baked pulse-based products ranged between 5.15–6.52 for chickpea flour-based muffins[22] and 5.9–7.2 for red kidney bean-based cupcakes[23,60]. These results show that adding pulses flour as a technological innovation to new food formulations can be positively accepted by consumers.

The study has several limitations, primarily the absence of physical and technological evaluations (e.g., texture, volume, colour, and specific volume) of the developed products. While the focus was on nutritional and sensory aspects, these technological properties are crucial for assessing the product's potential for mass production and long-term consumer acceptance. Additionally, to support its classification as a functional food, the new food formulation would benefit from a more detailed nutritional analysis, including understanding the antioxidant potential and the antinutritional properties, to understand if using the legume flour could have any disadvantageous outcome and if it would be recommendable to include a thermal flour treatment prior to the mix formulation. Future research should address these factors to offer a more comprehensive assessment of the product.

These results show the potential of legume grain-based foods innovations in breaking some of the barriers of the consumers towards low pulse consumption, such as lack of recognition of pulses' nutritional value and long cooking time[61]. Consumer acceptance of legume grains as alternative proteins is increasing, especially in light of their health and environmental benefits[20]. However, they are still generally perceived as less convenient and tasty[18,61]. There is common sense that current marketplaces have a growing demand for plant-based protein and that the food trends are in line with the need for more climate-positive products and protein alternatives[20].

Conclusions

This work presents and evaluates an innovative product, with a partial replacement of cereal flour with lentil flour. The goal was to obtain a gluten-free, vegan sweet bakery product with a nutritionally improved profile, well accepted sensorial profile, that the panellists admitted to being willing to buy if available on the market. Legume grain flours inclusion in food product development, inputs health, and environmental benefits.

More nutritious and environmentally friendly products are current marketplace demands and food innovation is one of the possible levers to promote the necessary changes in society's habits and perceptions to achieve the SDGs. Hence, it would also be of interest to perform a life cycle analysis to the products, showing any potential gains of using legume flours instead of the cereal counterparts.

This work demonstrates that product development with legume-grain flours may be accomplished using simple processing methodologies, with low technological investment requirements, which could be a lever to facilitate the promotion of such products' inclusion in value chains by the industry.

Data availability

Underlying data

Zenodo: Underlying data. https://doi.org/10.5281/zenodo.7521240[49].

The project contains the following underlying data:

- Data underlying.xlsx. (Anonymised survey responses to a sensorial analysis of a commercial and a lentil-based pre-made mixes for sweet pancake preparation).

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Extended data

Zenodo: Extended data. https://doi.org/10.5281/zenodo.7521292[48].

This project contains the following extended data:

- Data extended.docx. (Developed questionnaire for the sensory analysis of a commercial and a lentil-based pre-made mix for pancake preparation in English and in the original language (Portuguese))

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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Publisher Full Text

Open Peer Review

Current Peer Review Status: ? ? ? ? ? ? ? ✗

Version 2

Reviewer Report 22 April 2025

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✗

Hulya Cakmak
Hitit University, Corum, Turkey

The abstract should be revised for more scientific soundness, try to avoid exaggerated discussions like superior. Also, the authors mentioned about reduction of synthetic fertilizer use which is not quite relevant with the scope of this study.

Overall, the authors should avoid stressing on “sweet” pancake mixture. Is sweetness in top majority of their focus? Or legume flour addition?

In the introduction part, the authors mentioned about the nutritional profile of legumes (rich in proteins, fibers, low glycemic index etc.) however, it is better to introduce here a range of macro and micro nutrient levels for some common legumes focusing on their main legume source, such as protein ratio, carbohydrates, dietary fibers (soluble and insoluble) etc. Otherwise, their discussion of how good the nutrient composition remains week.
As they have mentioned in the introduction, conventional pancake premixes includes “usually cereal-based” ingredients. So they already do not include animal-based ingredients if egg is not added in the recipe. Therefore, their argument about reduction of animal-based ingredients mistargeted. Thus, I highly recommend reshaping the introduction based on their real aims.

Did authors use the same amount of water for commercial pancake mixture? Also, how did they decide the amount of water? Is it based on preliminary trials, or based on a literature study? If so, please explain or cite the relevant source.

Why did the authors test one only experimental lentil-based pancake formulation? and how that lentil amount was decided?

The authors should explain how they evaluated the nutritional composition of the lentil-based mixture? “Laboratory analysis” term does not explain the methods used! Also, they clearly explain which standard methods employed, how many replicates of experiments performed, what was the nitrogen conversion factor for calculating the protein amount, etc.
Also, they did not perform any statistical analysis for Table 1, if these two compositions had

significant differences. Also they should provide std. deviations for experimental formulation.

What is the source of fat in lentil-based mixture? Try to improve your discussion about fat accordingly.

The conclusion should reflect the findings of this study, not overestimates. So the authors should focus on the novelty of this study and what they brought to the current literature.

Overall, the experimental design could benefit from significant improvements, as it currently does not fully support the authors' stated objectives in the introduction. I would strongly recommend refining the experimental structure and expanding the discussion to better align with their research goals. In its current form, the manuscript may not yet be suitable for indexing, as its contribution to the recent literature appears somewhat limited

Is the work clearly and accurately presented and does it cite the current literature?
No

Is the study design appropriate and does the work have academic merit?
No

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: gluten-free product development, evaluation of nutritional composition, performing sensory analysis and discussing the results including statistical evaluations.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 21 March 2025

https://doi.org/10.21956/openreseurope.20646.r51816

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Alina Culetu
IBA Bucharest, Bucharest, Romania

The aim of the study was to present a formulation of a lentil flour-based premix for pancake production and compare with a commercial available product for nutritional composition and sensory analysis. There are more limitations of the study (related to the nutritional and technological characterization of the product) as it is stated already by the authors in the revised version of the manuscript, limitations which decrease the quality of the manuscript.
Other comments:
Introduction: On the sentence "They are natural soil fertilizers, reducing the use of synthetic nitrogen fertilizers ....." – I suggest to replace one of "they" with legumes.
On the Methods chapter: the Ethical statement sub-chapter needs to be together with the Participant recruitment information.
Discussion: Correct the typo in the sentence: "According to Regulation (EC) No 1924/2006, products with morels than 0.12 g of sodium per 100 g of product are considered 'low sodium'."
Why was the amount of 26.2 g red lentil flour/100 g dry mix used? Was there a preliminary study leading to this exact value?
Missing info if the experiment was replicated.
Missing info for the method of analysis for sodium analysis.
Title on Table 1 specifies "salt content". However, in the Table appears "sodium". Consider the uniformity.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
No

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Food chemistry and technology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 20 March 2025

https://doi.org/10.21956/openreseurope.20646.r51120

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Walaa AM Eid
New Valley University, El-Kharga, Egypt

The article studied the effect of the addition of lentil flour on the pancake, and studied the nutritional and sensory quality of pancakes enriched with lentil flour and compared with commercial counterpart.
The manuscript is a good piece of work. Still, this work is lacks precision and clarity of the idea.

- Moreover, the manuscript could benefit from some improvements in clarity and structure
- The language would benefit from some careful revisions to enhance clarity and flow
- The title is not appropriate and should be crisp.
- The aim of the study and its importance have not been determined.
- The analyses in the study are insufficient. Physical and technological properties of pancakes
- The results and discussion need further refinement for better clarification.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and does the work have academic merit?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Food Chemistry, Food Analysis, Food Waste Technology, Dates Manufacturing Technology, and food product development.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 18 March 2025

https://doi.org/10.21956/openreseurope.20646.r51819

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Yunus Temitayo Imam
Kwara State University, Ilorin, Kwara, Nigeria

- MANUSCRIPT TOPIC: The topic of the original manuscript is interesting and can be of importance to the pancake consumers, celiac patients and food industries.
- ABSTRACT: The abstract was well-written indicating the background, methods, key findings and conclusion. However, it seems the texts were not well aligned, consider justifying for even distribution of text. In the methods section, you may consider indicating the quantity or percentage of lentil substituted. In the result section, consider replacing “salt” with “sodium” to be specific. This will indicate which of the mineral salt is actually low.
- INTRODUCTION: The introduction is sufficient; however, consider enhancing the study’s novelty since numerous studies have investigated the use of legumes, including lentils, in the production of gluten-free products (Imam et al., 2024). To strengthen the introduction, provide information on the nutritional compositions and sensory properties of lentils. Additionally, consider rephrasing the main hypothesis to enhance clarity.
- MATERIAL: Provide details on the sample used in the study: sample source and preparation (milling, sieving, if any and storage). This may be essential for reproducibility.
- METHODS: Ensure clarity and specificity in the method section. The abstract and introduction section emphasize partial replacement of lentil, but this was not detailed in the formulation section (method). Specify whether 26.2 g was replaced and which cereals was replaced in the commercial flour. The easy mix pancakes contains 37 % of oat flour, provide the quantity of the other ingredients. Also, adding a table of formulation and/or ingredients can greatly enhance the clarity and readability of the formulation sections. Further, provide the procedure used to determine the carbohydrate and sodium content. Why are the total ash content and mineral content not included in the evaluation? Provide information on how the pancake was processed for the nutritional evaluation. E.g. was it dried to powder? Also, Consider evaluating the nutritional composition of the commercial flour mix too, this will enhance comparison with the lentil

- RESULT: Is the information on the commercial pancake not available on the pack label? This may still fit better than the retrieved data. Consider reporting the result of lentil pancake as mean and standard deviation or error since you have replicate baking.
- Table: consider rephrasing the title of Table 1 to make it specific and align with the manuscript title, objective and method. E.g. "Nutritional composition of ...." The "100 g" and "prepared according to instruction" in the title may be unnecessary

Consider adding "crude" to the fiber and protein i.e. crude fiber, crude protein.

- Figure: consider providing figures of the two pancakes, respectively, if available. The figure of the commercial flour can also be provided. Also, consider to replace data with bar i.e. Bar are means and SE...) and define what SE and n.s. (figure 3) means. Further, consider removing 'from 1 = completely disagree .... (Fig. 2) and from 1 = dislike extremely.....' since they have already been stated in the method section (page 4).
- CONCLUSION: is there any partial replacement? Specify.
- MANUSCRIPT: The manuscript contains some errors, these include:

1. Ensure consistent spacing between (%) unit and value. Figure 1, 28 % ($p < 0.0001$) and 22 %.... (Page 5. Remove space between value and % (unit)
2. Ensure consistent use of "lentil pancake", "lentil flour pancakes", lentil based pancake" and lentil-based pancake. Stick to one.
3. Clarify whether pancakes were fried or cooked. For example: Method: pancakes were prepared by "frying" and Result: the composition of the "cooked" lentil-based.
4. Discussion section: 'According to regulations (EC) No 1924..., products with "morels" than...' Clarify, morels or more.
5. Discussion section: celiac disease (about 1 % of the world's population). Clarify or add 'affect' to the sentence
6. Discussion section: 'in the present study, only a small percentage of panelist declared that generally consumes store-bought dry pancakes mix'. Clarify or add "the" before panelist" and "they" before generally.
7. Clarify whether the lentil-based pancake also contains salt and sodium bicarbonate as stated for the easy mix pancakes. These may have account for the high sodium content in the commercial pancake.

General comment: the manuscript requires significant revisions.

Reference:
Ref: 1

References

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Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and does the work have academic merit?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: functional food, Nutrition and nutraceutical

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 30 January 2025

https://doi.org/10.21956/openreseurope.20646.r49820

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Başak Öncel
Toros University, Mersin, Turkey

The review of the manuscript titled "Nutritional and Sensorial Analysis of a Lentil Flour-Based Sweet Pancake Premix" has been completed. The alignment between the study's title and the analyzes conducted is insufficient. While investigating the effect of lentil flour on the nutritional properties of pancakes, important parameters such as total phenolic content, antioxidant capacity, and mineral composition should have been included in addition to protein, fat, and fiber content. Furthermore, the absence of textural analysis and the excessive number of recommendations negatively impact the quality of the study. Overall, the scientific contribution of this study appears to be limited.

Specific Comments:

Introduction Section:

- Recent studies on the nutritional and sensory properties of lentil flour should be included and briefly summarized. Additionally, the aim of the study should be more explicitly stated

and emphasized at the end of the introduction.

Materials and Methods Section:

- In the Lentil-Based Pancake Formulation subsection, information regarding the raw materials (moisture, protein, fat, ash, etc.) should be provided, preferably in a table.

Reference Section:

- The reference for the statement "To each 100g lentil-based pancake mix..." should be cited within the paragraph.
- It appears that there are two sample groups: pancakes formulated with 26.2 g of red lentil flour and commercial pancakes. Please clarify this explicitly.
- A reference should be provided under the Statistical Analysis subsection.
- The absence of color and textural analyzes represents a critical methodological gap. The use of red lentil flour is expected to significantly influence color parameters, which in turn affect consumer preference. Therefore, colour analysis should be included.

Results Section:

- Only the lentil flour figure has been provided. Why were images of the pancakes not included?
- In the sensory analysis, why was the color properties not evaluated?
- In Figure 3, what specific textural parameter was expected by consumers (e.g., softness)?
- The Sensory Analysis subsection is a key component of the study; However, this aspect has not been adequately addressed in the

Discussion section.

- Please revisit this section and compare the results with recent studies.
- On page 7, the paragraph starting with "The study has several limitations..." is overly recommendation-based and should not be included in the Discussion section. Instead, this section should focus on interpreting the study's findings.

Conclusion Section:

- Instead of presenting recommendations, the conclusion should concisely summarize the main findings of the study.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and does the work have academic merit?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

No

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 24 January 2025

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Derya Alkan
Muğla Sıtkı Koçman University, Muğla, Turkey

Here are my comments on Manuscript titled: Nutritional and sensorial analysis of a lentil flour-based sweet pancake premix.

This manuscript includes the production of lentil-based pancakes and sensorial analysis of these pancakes. In my opinion, this manuscript is evaluated low in terms of the importance of the subject and scientific & presentation quality. Although the subject is important for the food industry and sustainability, the subject is not supported by sufficient analysis in this study.

The language quality of this manuscript is not good. There are many mistakes in grammar, structure, and word usage throughout the text. The use of very long sentences makes it difficult to understand both the fluency and understanding of the text. The whole article should be reviewed in terms of grammar, word usage, spelling mistakes.
The introduction and discussion sections are quite sufficient. However, I think there are some deficiencies of the manuscript. The lack of sample size makes it impossible to interpret the results of the study. The analytical and statistical analyses performed in this study are quite insufficient. Although the purpose of the study seems interesting, it is a very weak study in terms of experimental design, analyses, and statistical interpretation.

Specific comments:

1. How was the pancake formulation chosen? Why is red lentil flour added only 26%? Testing different ratios could have expanded data analysis.
2. No information was found regarding carbohydrate and sodium analysis in the method section. Missing methods should be added.
3. In order to make an accurate comparison, nutritional analysis of commercial pancakes should have been done using the same methods. In this way, the statistical evaluation of the data could be given more clearly in Table 1.
4. Although it is stated that t-test was applied in the statistical analysis section, comparison results are not given in the tables or figures.

We thank the authors for their efforts.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Food chemistry, Food packaging, Antioxidant and antimicrobial films.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Version 1

Reviewer Report 27 June 2023

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?

Marcia English
Saint Francis Xavier University, Antigonish, Nova Scotia, Canada

The article is well written, and the topic of the manuscript is interesting and can be instructional to readers. However, some sections of the manuscript need to be restructured for enhanced understanding to the reader. For example, in the abstract, the use of the term 'celiac' is not clear.

The authors should clarify that individuals with celiac disease must follow a gluten free diet. The background should also identify the problem or challenge that is being addressed in the study.

In addition, the introduction needs to outline previous studies that have been conducted in the field and clarify the specific research gap that the present work is addressing. By so doing the authors will be able to better clarify the novelty of the work. Moreover, the general hypothesis guiding the work should be highlighted.

The methods section of the paper needs to outline when and where the ingredients as well as the commercial pancake mix were purchased and stored. Also, what were the specific manufacturer's instructions for pancake preparation, time and temperature used? Ultimately, these processing parameters will impact the overall sensory and objective evaluations.

The physical properties (height, colour, and water activity) of the pancakes should also be determined.

For the sensory evaluation study, how many participants were recruited for the study, this information should be in the methods. Were the pancakes served without toppings/syrup or plain, and were they served warm? Also, the committee providing research ethics approval should be noted in the methods.

In the discussion, it is not accurate the describe the pancakes as 'functional foods' since the evidence provided in the study does not support this claim.

What are the implications of the findings from this work, given that pancake consumption is not widely adopted in Portugal, yet 63% of participants preferred the lentil-based product? What are the limitations of the study?

Conclusion: Products are available in the marketplace not in the 'market' as noted in the present study.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and does the work have academic merit?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Protein and flavour chemistry, fermentation and food product development.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 28 Nov 2024

Carla Santos

The article is well written, and the topic of the manuscript is interesting and can be instructional to readers. However, some sections of the manuscript need to be restructured for enhanced understanding to the reader. For example, in the abstract, the use of the term 'celiac' is not clear. The authors should clarify that individuals with celiac disease must follow a gluten free diet. The background should also identify the problem or challenge that is being addressed in the study. In addition, the introduction needs to outline previous studies that have been conducted in the field and clarify the specific research gap that the present work is addressing. By so doing the authors will be able to better clarify the novelty of the work. Moreover, the general hypothesis guiding the work should be highlighted.

Response: The authors agree with the Reviewer's observations and addressed the unclarity in the highlighted texts. This was addressed in the Introduction section and seven additional references were added to support the novelty aspect of the work done. Also, the hypothesis was added to the final paragraph of the Introduction section.

The methods section of the paper needs to outline when and where the ingredients as well as the commercial pancake mix were purchased and stored. Also, what were the specific manufacturer's instructions for pancake preparation, time and temperature used? Ultimately, these processing parameters will impact the overall sensory and objective evaluations. The authors thank the Reviewer for the detailed analysis of the methods and suggestions for improvement. The origin of the ingredients was added. The manufacturer only specified the amount of liquid to add to the powder, not time and temperature. We followed the same procedure to make both recipes, since a pancake maker machine was used. The physical properties (height, colour, and water activity) of the pancakes should also be determined. The authors understand the reviewers' observation. Indeed, the main focus of the study was to develop a gluten-free, vegan recipe that would maintain favourable sensory characteristics and an improved nutritional profile. We didn't consider the physical properties in this phase, as our primary objective was to assess consumer acceptance resulting from lentil flour incorporation. This was added to the Limitations of the Study. For the sensory evaluation study, how many participants were recruited for the study, this information should be in the methods. Were the pancakes served without toppings/syrup or plain, and were they served warm? Also, the committee providing research ethics approval should be noted in the methods.

Response: The authors agree with the Reviewer's suggestions and added the requested information. Both pancakes were served warm and a chocolate topping was made available for the participants to use as they like. This was also added to the Methods.

In the discussion, it is not accurate the describe the pancakes as 'functional foods' since the evidence provided in the study does not support this claim. The authors agree, removed this from the Discussion section and added to the limitations of the study. What are the implications of the findings from this work, given that pancake consumption is not widely adopted in Portugal, yet 63% of participants preferred the lentil-based product? What are the limitations of the study?

Response: Despite the fact that pancake consumption is not widely adopted in Portugal, the fact that 63% of participants expressed a preference for the lentil-based pancake suggests there is significant consumer interest in healthier, gluten-free alternatives. This could indicate a growing market for plant-based, nutritionally improved foods, even in regions where the product is not traditionally popular. It also highlights that with the right marketing and consumer education, there may be room for pancakes and other similar products to gain traction, especially among those with dietary restrictions or health-conscious consumers. The limitations of the study were added to the final

Conclusion: Products are available in the marketplace not in the 'market' as noted in the present study.
Response: This was changed.

Competing Interests: no competing interests to declare.

Reviewer Report 12 June 2023

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Elif Yaver
Konya Technical University, Selçuklu, Konya, Turkey

This study examined the effect of the addition of lentil flour on the pancake acceptability. The others investigated the nutritional and sensory quality of pancakes enriched with lentil flour and compared with commercial counterpart. The title is clear. The scientific quality of the study is low. The analyzes made in the study are insufficient. In addition;

- The novelty of the study is too low. There are many studies in the literature about enriched pancakes with legumes. For example: Obinna-Echem *et al.,* (2020)[1]; Adonu *et al.,* (2022)[2]; Beitane *et al.,* (2014)[3]; Guadagni & Venstrom (1972)[4]. What are the differences of this study from the literature? Please give more detail.

- The scientific quality of the study is low. The analyzes made in the study are insufficient. Physical and technological properties of pancakes (volume, weight, specific volume, texture, color, etc.) should be examined.

- In the abstract, celiac is not a type of consumer. I think it should be corrected as “celiac patients”.

- In Methods section, for all used material and chemicals manufacturer, city and country of origin should be written.

References

1. PC O, HI W, MAH C: Physical, Proximate Composition and Sensory Properties of Tigernut-Cowpea Flour Pancakes. *American Journal of Food and Nutrition*. 2020; **9** (1): 1-6 Publisher Full Text
2. Adonu RE, Afia AS, Aikins C: PROXIMATE COMPOSITION AND CONSUMER ACCEPTABILITY OF PANCAKESMADE WITH WHEAT AND SOYBEAN FLOUR BLENDS. *Journal of Critical Reviews*. 2022; **9** (4). Reference Source
3. Beitane I, Krumina-Zemture G, Murniece I: SENSORY, COLOUR AND STRUCTURAL PROPERTIES OFPANCAKES PREPARED WITH PEA AND BUCKWHEAT FLOURS. *Foodbalt*. 2014; **1**: 234-238 Reference Source
4. GUADAGNI D, VENSTROM D: PALATABILITY OF PANCAKES AND COOKED CORN MEAL FORTIFIED WITH LEGUME FLOURS. *Journal of Food Science*. 1972; **37** (5): 774-777 Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My areas of research are bakery products, cereal technology, legumes and food technology.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 28 Nov 2024

Carla Santos

Reviewer Comments:
This study examined the effect of the addition of lentil flour on the pancake acceptability. The others investigated the nutritional and sensory quality of pancakes enriched with lentil flour and compared with commercial counterpart. The title is clear. The scientific quality of the study is low. The analyzes made in the study are insufficient. In addition;

- The novelty of the study is too low. There are many studies in the literature about enriched pancakes with legumes. For example: Obinna-Echem et al., (2020)1; Adonu et al., (2022)2; Beitane et al., (2014)3; Guadagni & Venstrom (1972)4. What are the differences of this study from the literature? Please give more detail.

Author Response: The authors thank the reviewer's comment and agree that in the last years there have been increasing interest in these types of baked products and in improving their profiles with legume flours. The mentioned studies used different combinations: cowpea with tigernut (includes eggs and milk), soybean with wheat (includes eggs and milk), bean with cornmeal (salty recipe) and pea with buckwheat (includes milk). In our study we used oat flour and, for the first time, lentil flour to obtain a mixture carefully considered to achieve a vegan, gluten-free recipe. Lentils are particularly rich in flavonoids, which grants them an important role in antioxidant stress response. Also, lentil's gross production value has been steadily increasing and the fact that they possess different colour profiles valorises their potential to be exploited for different food applications. This was added to the introduction section, along with the references indicated by the Reviewer.

Reviewer Comments:

- The scientific quality of the study is low. The analyzes made in the study are insufficient. Physical and technological properties of pancakes (volume, weight, specific volume, texture, color, etc.) should be examined.

Author Response: The authors understand the reviewers' observation. Indeed, the main focus of the study was to develop a gluten-free, vegan recipe that would maintain favourable sensory characteristics and an improved nutritional profile. We didn't consider the physical properties in this phase, as our primary objective was to assess consumer acceptance resulting from lentil flour incorporation. This was added to the Limitations of the Study.

Reviewer Comments:
In the abstract, celiac is not a type of consumer. I think it should be corrected as "celiac patients".
Author Response: This was corrected.

Reviewer Comments:
In Methods section, for all used material and chemicals manufacturer, city and country of

origin should be written.
Author Response: This was added.

Competing Interests: no competing interests to declare.