Study of the physical, chemical and sensory properties of laboratory-prepared pasta by replacing wheat flour with pea flour

Alyaa S. Al-Hafud 1* ,Shahad khalid hameed al-janabi2
1Department of Home Economics/ College of Education for Women University of Baghdad/ Iraq
2Department of Home Economics/ College of Education for Women University of Tikrit
Corresponding author's email: Aliasaad80@coeduw.uobaghdad.edu.iq
Shahad.hameed@tu.edu.iq

Abstract
The current study aimed to use green peas in pasta production by replacing the peas after drying and grinding them well with wheat flour in specific proportions as follows: Treatment (A) is the control sample 100% wheat flour (200 g), Treatment (B) replaced 20% (40 g) peas, Treatment (C) replaced 40% (80 g) peas, Treatment (D) replaced 60% (120 g) peas. Chemical tests were conducted, which included moisture, fat, protein, ash, fiber, and carbohydrates. The results showed that the highest rate was recorded in treatment D which contained moisture content of 39.94, ash of 1.17, protein of 9.84, crude fat of 3.31, fiber of 4.17, carbohydrates of 63.55. Treatment D also excelled in mineral tests, which were the results of calcium (Ca), iron (Fa), and magnesium (Mg) (140.0, 14.30, 396.0) respectively. While the results of the sensory evaluation of the samples, which included (color, flavor, texture, taste, and general acceptance), recorded the superiority of treatment (B) over other addition treatments in sensory qualities. It was noted from the results that the addition ratio is inversely proportional between the chemical and mineral tests and the sensory evaluation. The higher the addition ratio, the lower the sensory evaluation scores. In general, the general acceptance of all treatments was acceptable, and peas can be used in other food products in addition to Increase nutritional value.

Keywords: pea flour, processed pasta, physicochemical tests, sensory.

Introduction

Pasta is one of the well-known foods around the world due to its ease of preparation and high ability to store, in addition to its low cost and speed of preparation. It is considered one of the foods rich in carbohydrates, with a percentage of about (70-76%), protein (10-14%), fat (1.8%) and fiber. (2.9%) and small amounts of minerals and vitamins, but the interest in fortified foods led to increased interest in fortified pasta due to its health and marketing. (24.(

Pasta is made from durum wheat flour or from regular wheat flour as its main ingredient. Fortified pasta is produced by adding nutritional ingredients to improve its nutritional value or function. Research efforts have been directed towards improving new fortified pasta products. Fortified pasta is made by replacing part of the wheat flour with a combination of plant-based ingredients (20),(2(

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Due to the nutritional properties of legumes because they contain a high percentage of proteins, fibres, vitamins, minerals, and calories, in addition to phytochemicals, this

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has given them special attention by food producers and manufacturers (13.(

Adding legume flour is a promising strategy for improving food quality, especially proteins and fortifying low amounts of some amino acids such as lysine. On the other hand, legumes are characterized by fixing nitrogen and improving soil properties, which enhances the production of sustainable crops (5.(

The different properties of legume flours from wheat flour may create technological challenges due to the different functional properties when replacing legume flours compared to wheat gluten (26).(6(

The presence of legumes can be undesirable for consumers of pasta made from legume flour. Therefore, several processing strategies have been applied to overcome these limitations (22.(

Peas (Pisum sativum) contain high percentages of starch, which is considered a major source of complex carbohydrates. This type of starch is characterized by containing a high percentage of amylose (24-65%), which is characterized by low digestibility (21.(

Slow-digesting, resistant starches contribute to the low glucose content of starch-based food products, and are considered a good advantage in controlling diabetes and hyperlipidemia. This property enables the use of leguminous starches in fortified food foods, which leads to an increase in their value in the low-fat, high-fiber food industries, which They help reduce the risk of obesity, heart disease, and colon cancer (25).(8(

In addition to the above improvements, fortifying pasta products with legumes such as peas has a positive effect on human health as they are rich in nutrients and some minerals and vitamins (11.(

The protein content of peas (225 g/kg) relative to dry matter gives it an advantage for use as an alternative to animal-derived proteins, which helps in enhancing cereal protein used as a healthy diet and improving the nutritional status of cereal-based diets, and the protein groups of legumes make them particularly beneficial because cereal proteins lack some essential amino acids, especially lysine (4.(

The presence of high amounts of lysine in peas and due to its plant composition and basic components can increase the protein content of cereal-based diets, and the high amounts of protein, low glucose and high fiber content are other factors that help in the biological activities necessary for human health (23 .(

Accordingly, there has been increasing interest in processed foods fortified with peas (16.(

Materials and methods

How to make pasta

The method of Shikha et al ,was followed in preparing pasta with some simple modifications according to the following steps and quantities:

-Basic treatment (control(

-1 Put 200g of flour in the mixing bowl.

-2 Add 1g of salt to the flour

-3 Add one egg to the mixture

-4 Add water to the dry ingredients and mix the ingredients well with a spoon several times until the dough is homogeneous

-5 Leave the dough for half an hour to rest

-6 Put the dough in the pasta machine until it reaches the desired consistency

-7 Then we cut the dough with a knife into small squares and formed it into a bow shape. After that, it was placed in molds until it dried completely.(19(

How to prepare the treatments:

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Ground peas were used and added to the pasta recipe in the following proportions:

The first treatment is the basic recipe, symbolized by A, consisting of 100% wheat flour, 200 g.

The second treatment, symbolized by B, consists of 20% peas (40 g pea flour and 160 g wheat flour.(

The third treatment, symbolized by C, consists of 40% peas (80 g peas and 120 g wheat(

The fourth treatment, symbolized by D, consists of 60% (120 g peas with 80 g wheat(

Knead each treatment separately and add warm water according to the dough's need and leave for half an hour, then shape it with the machine.

Chemical tests:

Moisture and ash were estimated according to the methods mentioned in (3.(

Fat:(%)

The percentage of fat was estimated using the Soxhlet apparatus described in (3.(

Protein:(%)

The percentage of total nitrogen was estimated based on AOAC according to the Semi-Micro Kjeldahl method and the conversion factor (5.7) was used to extract the percentage of protein in the dry samples of the mixtures. (3(

Fiber Estimation:

The crude fiber in the dry samples was estimated according to the method mentioned in (3.(

Carbohydrate percentage:

Carbohydrates were estimated mathematically according to the following equation and according to Pearson et al:

Carbohydrate percentage = 100- (moisture + protein + fat + ash + fiber). (17(

Estimation of mineral elements:

The following mineral elements (magnesium, iron and calcium) were estimated according to AACC where X-ray fluorescence technique was used to estimate the concentrations of chemical elements in dry samples of the mixtures (1.(

Measuring water retention capacity:

The method of Metal was followed to measure the percentage of water absorption when boiling pasta and it can be calculated by measuring the weight of the dry pasta before boiling and after boiling. The difference between the two weights represents the weight of water absorbed by the pasta..

Steps to calculate the water absorption rate when boiling pasta:

.1 Measure the weight of a certain amount of dry pasta before boiling accurately and record the weight using an accurate scale.

.Boil the pasta.2

.3After boiling, drain the pasta well to get rid of excess water.

.4 Measure the weight of the pasta after boiling accurately and record it.

.5Calculate the difference between the final weight and the original weight of the pasta to find out how much water it has absorbed.(14(

Sensory evaluation:

The sensory evaluation was conducted by a number of food science specialists based on qualitative characteristics (general acceptance, taste, texture, flavour, colour) and according to the method approved by AACC (1). The evaluation was conducted by 10 experts in the field of nutrition.

Statistical analysis:

The SAS program was used to analyses the different parameters of the experiment and that significant differences between the averages were tested with the least significant difference (L.S.D) (18.(

Results and discussion:

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Table 1: Chemical tests of research samples

Carbohydrates	Crude Fiber%	Crude Fat %	Crude Protein%	Ash%	Moisture %	properties / treatments
28.53	2.02	1.16	6.56	0.37	61.36	A
41.57	3.15	2.21	7.66	0.89	45.29	B
43.65	4.17	2.83	8.75	1.04	41.82	C
63.55	4.16	3.31	9.84	1.17	39.94	D

A control, B = 20% pea flour, C = 40% pea flour, D = 60% pea flour.

highest value of the protein was obtained in the treatment (9.84) D, while lowest value of protein percentage was in treatment (6.56) A.
Treatment D recorded highest value in fats, which amounted to (3.31), while treatment A recorded lowest value, which amounted to (1.16) in terms of fat percentage, while the fiber percentage recorded highest value in treatment D, which amounted to (4.17), and lowest value was also obtained by treatment A, which recorded (2.02). As for carbohydrates, highest value was obtained in treatment D (43.65), and lowest value was obtained by treatment A in terms of carbohydrates A(28.53.(
It is noted that when the percentage of pea flour increases, the value of ash, crude protein, crude fat, fiber, and carbohydrates increases. These results were close to what was found by the researcher Kohajdová et al., 2013, (27) in the manufacture of biscuits, where the moisture reached (7.92), the protein percentage reached (21.6), the fat percentage (1.13), the ash percentage (3.11), and the carbohydrate percentage (66.38.(
While the moisture content decreases when pea flour increases, this is due to the protein content of pea flour, which is characterized by its high ability to absorb large amounts of water, which limits the availability of water to develop the gluten network when it competes with wheat proteins (rheological properties) (7), in addition to increasing the fiber content of pea flour, and as a result, the moisture content decreases when the percentage of pea flour increases (10.(

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Table (2) Samples of mineral elements

Ca Ppm	Fe ppm	Mg Ppm	elements / Samples
81.8	7.20	108.0	A
85.0	8.30	262.6	B
91.0	10.90	364.0	C
140.0	14.30	396.0	D

Table (2) shows that the mineral elements tests for the research samples had highest value for calcium in treatment D (140.0) and lowest value was obtained by treatment A (81.8). In terms of iron, highest value was obtained in treatment D (14.30) and lowest value was obtained by iron (7.20) A. As for magnesium, highest value was obtained by treatment D (396.0) and lowest value was obtained by treatment A (260.6). These results are considered positive due to the human need for these main elements compared to pasta made from wheat.

Table 3: Water holding:

Weight before boiling G	**Weight after boiling G**	**Treatment**
gm **30**	**gm 65**	**A**
gm **30**	gm **42**	**B**
gm **30**	gm **45**	**C**
gm 30	gm **45**	**D**

The above table (3) shows an increase in the water holding capacity of treatment A and a gradual decrease with increasing the addition ratio, which reached 45 g in treatment D. The study by El-Rab et al (9) concluded that the addition treatments of molten meat with sand to enhance pasta led to a decrease in the loss rate when increasing the addition ratio in the treatments. These results are consistent with the findings of Nawaz et al. (15.(

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Table 4: Sensory evaluation of research samples:

General Acceptance	Taste	Texture	Flavour	Color	treatment
6.5	6.7	6.3	6.6	7	A
4.4	4	5.4	4.8	6.1	B
3.5	3.7	4.6	3.7	5	C
3.1	2.1	3.5	3.9	5.1	D

Table (4) shows that treatment A received highest sensory evaluation in terms of colour, flavour and stickiness because it was a basic sample of wheat flour. After that came treatment B, which also received a high evaluation, but it was lower than treatment A. The colour percentage was (6.1), flavour (4.8), texture (5.4), taste (4) and general acceptability (4.4). As for treatment C and D, they received lowest sensory evaluation in terms of colour, flavour, texture, taste and general acceptability because the percentage of pea flour was higher, so the taste appeared clearly in the processed pasta.

It was noted through the sensory evaluation results that increasing the percentage of pea flour gave low results in general acceptance, taste, texture, flavour and colour. This was also noted in the study of Kohajdová et al, 2013. (27) It was proven that reducing peas to 20% achieves much better results in the sensory test.

These results are consistent with (12) whose study found that reducing legume flour to 20% pea protein flour in the product achieves significantly better results in such a sensory test.

Conclusion:

According to the results obtained from the design industries, slow peas are used to improve the quality of the product and increase the nutritional value and qualitative characteristics with creativity between the mixture ratio, the exact replacement of peas and flour in a way that maintains the general acceptability values of ragala and processed pasta.

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References

[1]AACC(2000),American Association Of Chemistry .Approved methods of analysis,8thEd St Paul,Minnesota ,U.S.A.

and sensory evaluation and essential amino acid content. Ciência Rural, Santa Maria, v.52:7, e20200693.

[2]Andréa Alves Seixas Lima, Deborah Murowaniecki Otero , Camila Duarte Ferreira-Ribeiro Márcia Regina da Silva ,(2019). Wheat Substitutes for Gluten-Free Pasta: An Integrative Review. Journal of Biotechnology Research , ISSN(e): 2413-3256, ISSN(p): 2413-8878 , Vol. 5, Issue. 10, pp: 100-106 .

[3]AOAC Association of Offical Analytical Chemistry .In K. Herlich(1990).(Ed.),Official methods of analysis (18th ed.). Washington ,DC,USA.

[4]Böhm, H.; Aulrich, K.; Berk, A. Rohprotein—und Aminosäurengehalte in Körnerleguminosen und Getreide; Content of Protein and Amino Acids in Grain Legumes and Cereals; Zwischen Tradition und Globalisierung—9. Wissenschaftstagung Ökologischer Landbau, 20–23 March 2007; Universität Hohenheim: Stuttgart, Deutschland.

[5]Boukid, F.; Rosell, C.M.; Rosene, S.; Bover-Cid, S.; Castellari, M.(2022), Non-Animal Proteins as Cutting-Edge Ingredients to Reformulate Animal-Free Foodstuffs: Present Status and Future Perspectives. Crit. Rev. Food Science and Nutrition.62, 6390–6420 .

[6]Boukid, F.; Vittadini, E.; Lusuardi, F.; Ganino, T.; Carini, E.; Morreale, F.; Pellegrini, N.(2019). Does Cell Wall Integrity in Legumes Flours Modulate Physiochemical Quality and in Vitro Starch Hydrolysis of Gluten-Free Bread? J. Funct. Foods , 59, 110–118 .

[7]Des-Marchais, L.P., Foisy, M., Mercier, S., Villeneuve, S., Mondor, M. (2011): Bread-making potential of pea protein isolate produced by a novel ultrafiltration/diafiltration process. Procedia Food science. 1, 1425-1430. first_page.

[8]Dobson, Stacie, Erica Pensini ,John H.Dupuis ,Rickey Y.Yada , Alejandro G.Marangoni.(2023)."Synergistic interactions between pea protein isolate and rapid-swelling starch."Food Hydrocolloids (14): 108753.

[9]El-Rab , Zeinab A. H. Abdalla S. Abdel-Gawad;Badawy M. D. Mostafa1; Manal A. M. Hassan & Ahmed H. Khalifa(2024). Improving Nutritional Quality of Gluten Free Noodles Using Sand Smelt (Atherina boyeri) Fish, Assiut Journal of Agricultural Sciences 55 (2) (80-92); ISSN: 1110-0486 / EISSN: 2356-9840.

[10]Gomes ,Daiane de Souza , Lucas Silva Rosa , Layse do Prado Cordoba, Fernanda Fiorda-Mello , Michele Rigon Spier , Nina Waszczynskyj,(2022) Development of muffins with green pea flour and their physical, food Thchnology .Cienc, Rural 52(7 .(

[11]Iqbal, A.; Khalil, I.A.; Ateeq, N.; Sayyar Khan, M. (2006),Nutritional quality of important food legumes. Food Chemistry. 97, 331–335.

[12]Linsberger, G.; Schonlechner, R.; Berghofer, E. Herstellung von Keksen, Snackprodukten und Teigwaren aus Getreide und einheimischen Leguminosen. Nutrition 2006, 30, 505–514

[13]Mefleh, M.; Pasqualone, A.; Caponio, F.; Faccia, M.(2022). Legumes as Basic Ingredients in the Production of Dairy-Free Cheese Alternatives: A Review. Journal of science of food and agriculture., 102, 8–18 .

Moreno-Araiza, O.; Boukid, F.; Suo, X.; Wang, S.; Vittadini, E.(2023). Pretreated Green Pea Flour as Wheat Flour Substitutes in Composite Bread Making. Foods, 12, 2284 .

[14]Metall, Ahmed Abdel. (2009), Information Technology for Business. University publisher. Issue 27 October.

[15]Nawaz, A.; Li, E.; Khalifa, I.; Irshad, S.; Walayat, N.; Hamed, H.H.M.; Zhang, Z.; Ahmed, S. and Simirgiotis, M.J. (2020) Evaluation of fish meat noodles: physical property, dough rheology, chemistry and water distribution properties. International Journal of Food Science and Technology, 1-9

[16]Nette, A.; Wolf, P.; Schlüter, O.; Meyer-Aurich, A.(2016), A Comparison of Carbon Footprint and Production Cost of Different Pasta Products Based on Whole Egg and Pea

Flour. Foods, 5, 17. https://doi.org/10.3390/foods5010017

[17]Pearson ,D ,E . Harold :S.K.Ronald ; and S.Ronald (1981).Chemical analysis of food.Churchill Livingston .New York,USA.

[18]SAS,(2012).Statisticalysis System ,Users Guide .Statistical.Version9th ed.SAS.Inst.Inc.N.C.US.A.

settings

[19]Shikha, F. H.; Ismall, M.D.; Hossain and Farzana, L. (2020). Development of noodles with low cost silver carp fish (Hypophthalmichthysmolitrix) mince. Bangladesh J. Fish, 32(1): 107-114.

[20]Suo, X.; Dall'Asta, M.; Giuberti, G.; Minucciani, M.; Wang, Z.; Vittadini, E.(2022), The Effect of Chickpea Flour and Its Addition Levels on Quality and in Vitro Starch Digestibility of Corn–Rice-Based Gluten-FreePasta. International journal of food sciences and nutrition Journal. Food Sci. Nutr, 73, 600–609 .

[21]Talha,, Muhammad Khair, Muhammad Muhammad, Obaida Al-Abdullah. (2011). Effect of antioxidant process on tender green peas. Damascus University Journal of Agricultural Science . Volume (27) - Issue 2 - Pages: 153.

[22]Wang, Y.; Jian, C. (2022), Sustainable Plant-Based Ingredients as Wheat Flour Substitutes in Bread Making. Npj Science of Food. 6, 49 .

[23]Xu,B.; Chang, S.K.C.(2012), Comparative study on antiproliferation properties and cellular antioxidant activities of commonly consumed food legumes against nine human cancer cell lines. Food Chemistry. 2012, 134, 1287–1296.

[24]YILMAZ, M. T. Yildiz .Onder.Bayram Yurt , Omer Said Toker . Safa Karaman .Ayhan Basturk. (2015). A mixture design study to determine interaction effects of wheat, buckwheat, and rice flours in an aqueous model system LWT - Food Science and Technology Volume 1 , Issue2, May, Pages 583-589.

[25]Z. Pietrasik, J.A.M. Janz .(2010). Utilization of pea flour, starch-rich and fiber-rich fractions in low fat bologna Food Research International Volume 43, Issue 2, March ,Pages 602-608.

[26]Zhang, Y.; Hu, R.; Tilley, M.; Siliveru, K.; Li, Y.(2021). Effect of Pulse Type and Substitution Level on Dough Rheology and Bread Quality of Whole Wheat-Based Composite Flours. Processes, 9, 1687.

[27]Zlatica Kohajdová* , Jolana Karovičová, M. Magala.(2013). Rheological and qualitative characteristics of pea flour incorporated cracker biscuits. Croat. Journal. Food science. Technol.5 (1) 11-17.

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