



Study of the nutritional quality of peas (*Pisum sativum* L.) under different conservation conditions

Amina Mohamed^{1, 2*}, Samir Tlahig¹, Jamila Yehmed Moussa¹ & Mohamed Loumerem¹

¹Dryland and Oases Cropping Laboratory, Arid Land Institute. Street El Jorf, 4119, Medenine (Tunisia)

²Higher Agronomic Institute, Chott Mariem, IRESA-University of Sousse. B.P 47, 4042 Chott Mariem, Sousse (Tunisia)

Article info

Article history:

Received: 15 June 2024

Accepted: 29 October 2024

Keywords: *Pisum sativum*, Polyphenol, Flavonoid, Antioxidant activity, conservation.



Copyright©2024 JOASD

*Corresponding author

mohamedamina189@yahoo.com

Conflict of Interest: The authors declare no conflict of interest.

Abstract

Peas (*Pisum sativum* L.) are among the most widely cultivated legumes, known for their adaptability to dry and warm environments and their high nutritional value. This research aimed to investigate the biochemical diversity of proteins, polyphenols, flavonoids, tannins, and antioxidant activity in a local population of peas from the Mareth oasis in Tunisia under different preservation methods: fresh, frozen, canned, and dried. The hypothesis was that preservation methods significantly impact the nutritional quality of peas, with fresh peas retaining the highest levels of essential nutrients. The results showed that fresh peas had superior nutritional quality, demonstrating the highest concentrations of protein (39 mg/g MF), polyphenols (0.17 mg GAE/g MF), flavonoids (0.086 mg QE/mg MF), and antioxidants (52%). In contrast, dried peas exhibited the lowest nutrient levels, particularly in protein and antioxidant activity. The study highlighted that freezing is an effective method for preserving the nutritional integrity of peas compared to canning and drying, which significantly reduce essential nutrient levels. Understanding the effects of various preservation techniques is crucial for maintaining the nutritional quality of peas. These findings have significant implications for consumers and the food industry, advocating for practices that prioritize the retention of nutrients in preserved peas. This research contributes to the ongoing discourse on food preservation methods and their impact on nutritional quality, providing insights that support better choices in food processing and consumption.

1. INTRODUCTION

Peas (*Pisum sativum* L.) are widely cultivated legumes valued for their adaptability to various climates, including dry and warm environments. They are an essential component of the diet in many parts of the world, providing high levels of protein, dietary fiber, vitamins, and minerals. This nutritional profile, combined with their versatility, makes peas a significant dietary staple, with global production reaching approximately 10 million tons for fresh peas and 7 million tons for dried peas (Lara & Tsiami, 2024). As consumers increasingly prioritize nutrient-rich foods, it becomes essential to understand how different preservation methods affect the nutritional quality of peas.

Preservation techniques such as freezing, canning, and drying are commonly used to extend the shelf life of peas and ensure their year-round availability. However, these

processes can significantly alter the nutrient content of the peas. Previous studies have shown that nutrient retention depends on factors such as temperature, humidity, and storage duration (Xie et al., 2018; Wang et al., 2020). For example, freezing has been shown to retain higher levels of vitamin C compared to canning, while drying can lead to substantial changes in protein structure and amino acid availability. These findings suggest that preservation methods may have varying effects on the health benefits derived from pea consumption.

Antioxidants, polyphenols, and flavonoids, which are known for their protective health effects, are particularly susceptible to degradation when exposed to heat and oxygen (Makris & Rossiter, 2001). These bioactive compounds play a critical role in reducing oxidative stress and may provide protection against chronic diseases. Maintaining these compounds during

preservation is crucial for maximizing the health benefits of peas and meeting consumer demand for functional foods with added health advantages.

The hypothesis of this study is that preservation methods significantly impact the nutritional quality of peas, with fresh peas retaining the highest levels of protein, polyphenols, flavonoids, tannins, and antioxidant activity compared to frozen, canned, and dried forms. Specifically, it is expected that more intensive preservation methods, such as drying, will result in greater losses of these essential nutrients.

To test this hypothesis, the study aims to evaluate the effects of fresh, frozen, canned, and dried preservation methods on the nutritional quality of a local population of peas from the Mareth oasis in Tunisia. The objectives are to quantify protein content to assess the impact on protein retention; measure polyphenol, flavonoid, and tannin levels to determine the preservation effects on bioactive compounds; and evaluate antioxidant activity using the DPPH assay to understand how antioxidant capacity varies with different storage methods. The findings are intended to provide practical guidance for consumers and the food industry on selecting preservation techniques that maintain the nutritional integrity of peas.

In summary, this research seeks to balance the need for extending shelf life with the goal of preserving essential nutrients, ultimately supporting consumer health and informing food processing practices that prioritize nutrient retention.

2. MATERIAL AND METHODS

2.1. Plant material

This study utilized a local population of peas (*Pisum sativum* L.) cultivated in Tunisia's arid Mareth oasis. These peas were preserved in four distinct forms: fresh, frozen, canned, and dried. Fresh peas were analysed immediately after harvest, while frozen peas were stored at -18°C for two months to simulate standard household freezing conditions. Canned peas were preserved by heating at 85°C for four minutes, replicating typical industrial canning procedures. Dried peas were air-dried at ambient temperatures ranging from 20°C to 30°C over two weeks. These methods were chosen to reflect common conservation techniques and allow a realistic assessment of nutritional changes.

2.2. Determination of protein content

Protein concentration was measured using the Bradford assay, a colorimetric method ideal for protein quantification (Bradford, 1976). The Bradford reagent was prepared by diluting Coomassie Brilliant Blue G-250 dye in an acidic solution. Standard protein solutions were created with bovine serum albumin (BSA) to establish a standard curve. For each test, $10\ \mu\text{L}$ of sample was mixed with 2 mL of Bradford reagent and incubated at room temperature for 5-10 minutes. The absorbance was then measured at 595 nm with a spectrophotometer. The resulting data were plotted against the BSA standard curve to calculate sample protein concentrations.

2.3. Preparation of Methanolic Extract for Antioxidant Analysis

2.3.1. Preparation of methanolic extract

Methanolic extracts were prepared to evaluate phenolic compounds, flavonoids, tannins, and antioxidant activities. For each sample, 0.5 g of pea tissue was homogenized with 5 mL of methanol and stirred for 30 minutes using an electric stirrer. The mixture was kept in the dark at 4°C for 24 hours to optimize extraction. After incubation, the mixture was filtered, and the filtrate was concentrated with a rotary evaporator to remove methanol. The resulting extracts were stored at 4°C until further analysis.

2.3.2. Total polyphenols content

Polyphenols were quantified using the Folin-Ciocalteu method (Singleton et al., 1999). Each extract was mixed with Folin-Ciocalteu reagent and sodium carbonate. After incubation for 30 minutes in the dark, absorbance was read at 760 nm. A gallic acid standard curve was prepared to express results as gallic acid equivalents (GAE) per gram of fresh mass (MF). All measurements were performed in triplicate to ensure reliability.

2.3.3. Total flavonoid content

Flavonoid content was measured following the Dewanto et al. (2002) method. Extracts were combined with sodium nitrite, aluminum chloride, and sodium hydroxide solutions. The absorbance was measured at 510 nm, and results were expressed as quercetin equivalents (QE) per gram of fresh mass. A catechin standard curve was used to determine flavonoid concentrations. Triplicate measurements ensured accuracy.

2.3.4. Condensed tannin content

Condensed tannins were assessed using the vanillin-HCl method (Broadhurst & Jones, 1978). Samples were mixed with vanillin reagent and hydrochloric acid, and then incubated for 20 minutes. The absorbance at 500 nm was measured and compared to a catechin standard curve to express results as catechin equivalents (CE) per gram of fresh mass. Measurements were performed in triplicate for consistency.

2.3.5. Assay of antioxidant activity DPPH

Antioxidant activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method (Brand-Williams et al., 1995). A DPPH solution was prepared at 0.1 mM concentration in methanol. Sample extracts were added to this solution, and the reaction mixture was left in the dark for 30 minutes. Absorbance was recorded at 517 nm, with antioxidant activity calculated as the percentage of DPPH inhibition using the formula: % inhibition = $[(A0 - A1) / A0] \times 100$, where A0 represents the control absorbance, and A1 represents sample absorbance.

2.4. Statistical analysis

Data were analysed using SPSS 20.0 software. An ANOVA test was used to assess differences between preservation methods, with mean comparisons made using Student's t-test at a significance level of 5%. All experiments were conducted in triplicate, and results were reported as mean \pm standard deviation to ensure robustness.

3. RESULTS

3.1. Protein content

The protein content of peas varied significantly depending on the preservation method used, as shown in Fig. 1. Fresh peas demonstrated the highest protein concentration, with 39 mg/g MF, while dried peas had the lowest concentration, at 21 mg/g MF. This decline in protein content from fresh to dried peas can be attributed to processing methods, such as heat treatment during drying, which may cause protein denaturation (Jiang et al., 2014). Thus, fresh peas are the most beneficial option for protein intake, though freezing and canning also retain a considerable amount of protein.

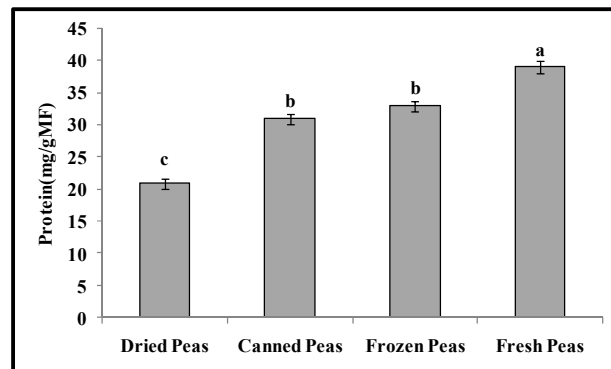


Fig. 1. Variation of pea protein content under different storage states.

3.2. Polyphenols content

Polyphenols, known for their antioxidant properties, showed notable differences across preservation methods. Fresh peas had the highest polyphenol content (0.17 mg GAE/g MF), followed by canned (0.08 mg GAE/g MF), frozen (0.07 mg GAE/g MF), and dried peas (0.064 mg GAE/g MF) (Fig. 2.). This suggests that fresh peas have a polyphenol concentration more than double that of canned peas, the next highest preserved form. The reduction in polyphenol content in dried peas implies that drying could lead to substantial losses in these beneficial compounds (Whent et al., 2023). Therefore, consuming fresh peas maximizes polyphenol intake, though canned and frozen options retain moderate amounts compared to dry.

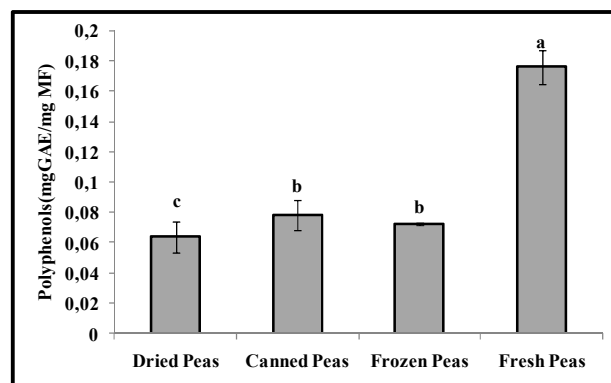


Fig. 2. Variation in the polyphenol content of peas under different conservation states.

3.3. Flavonoids content

Flavonoids, which contribute to the antioxidant capacity of plants, also varied depending on the conservation state. Fresh peas exhibited the highest flavonoid content at 0.086 mg QE/mg MF, followed by frozen (0.052 mg QE/g MF), canned (0.05 mg QE/mg MF), and dried peas (0.043 mg QE/mg MF) (Fig. 3.). The

decline in flavonoid levels from fresh to dried peas indicates that the preservation method significantly impacts these compounds. Freezing appears to be an effective method for retaining flavonoid content, as frozen peas maintained a higher level than canned and dried peas. This makes freezing a viable option for preserving flavonoid-rich peas.

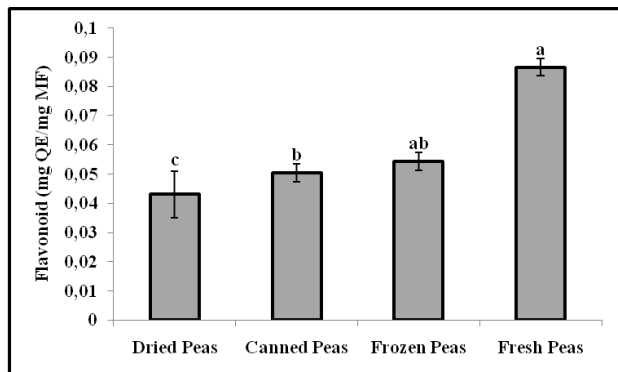


Fig. 3. Variation of pea flavonoid content under different conservation states.

3.4. Condensed Tannins content

Condensed tannins, which are known to affect protein digestibility, also showed variability based on preservation method. Fresh peas contained the highest tannin content (75.93 mg CE/g MF), while dried peas had the lowest (47.71 mg CE/g MF) (Fig. 4.). The pattern observed suggests that less intensive preservation methods, like freezing, help maintain tannin levels compared to more extensive methods, such as drying. These findings highlight that immediate consumption or minimal processing, like freezing; can preserve tannins better than drying or canning.

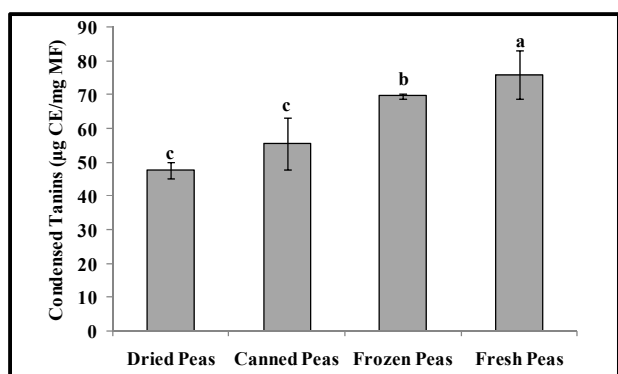


Fig. 4. Variation in pea tannin content under different conservation states.

3.5. Antioxidant activity (DPPH)

The antioxidant activity, assessed through the DPPH assay, revealed significant differences

among preservation states. Fresh peas exhibited the highest antioxidant activity, with a 52% inhibition rate, indicating robust antioxidant potential. Frozen peas followed with 31%, then canned (26%), and lastly, dried peas (8%) (Fig. 5.). These findings underscore the substantial reduction in antioxidant capacity that can result from intensive processing, particularly drying. To retain the antioxidant benefits of peas, fresh consumption is ideal, although freezing retains a considerable amount of antioxidants compared to other preservation techniques.

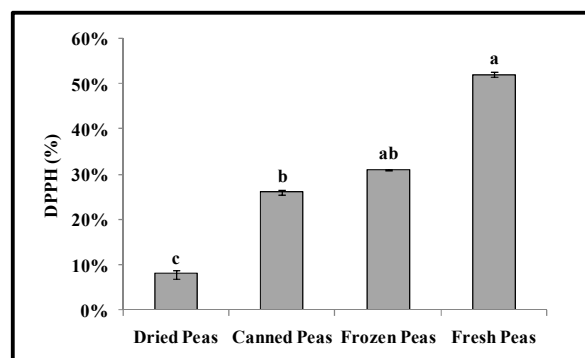


Fig. 5. Percentage of pea DPPH radical scavenging activity under different conservation states.

4. DISCUSSION

The preservation of peas in various forms—fresh, frozen, canned, and dried—significantly impacts their nutritional composition. This study highlights that fresh peas generally maintain superior nutritional quality compared to preserved forms, especially in terms of protein content, polyphenols, flavonoids, tannins, and antioxidant activity. These findings align with prior research, underscoring the sensitivity of these compounds to conservation methods. The results indicate that fresh peas have the highest protein content, followed by frozen and canned forms, with dried peas exhibiting the lowest levels. The reduction in protein content observed in dried peas may result from protein denaturation due to heat treatment and prolonged storage, as supported by studies like Jiang et al. (2014). This degradation can compromise the bioavailability and nutritional value of protein in dried peas. Thus, for consumers seeking maximum protein intake, fresh peas are recommended. However, freezing and canning offer alternatives that maintains relatively high protein levels, making them viable options when fresh peas are unavailable. Polyphenols and flavonoids, crucial for their antioxidant properties, showed a marked decline

in preserved peas compared to fresh. Fresh peas had the highest levels of both polyphenols and flavonoids, highlighting their potential as a rich source of bioactive compounds when consumed in their unprocessed form. Dried peas, in particular, exhibited significant losses, which could be due to the oxidation of polyphenolic compounds during drying, as well as the reduction in moisture content, which affects compound stability (Whent et al., 2023). These findings are consistent with literature suggesting that polyphenols and flavonoids are sensitive to heat and oxygen exposure (Makris & Rossiter, 2001). Interestingly, freezing retained more of these compounds compared to canning, indicating that freezing is a better method for preserving bioactive compounds in peas. This supports the findings of studies such as Wang et al. (2020), which highlight freezing as a more protective technique for polyphenols and flavonoids in vegetables.

Condensed tannins, which can influence protein digestibility by binding to proteins and reducing their availability, were highest in fresh and frozen peas. The tannin content in dried and canned peas was notably lower, likely due to leaching during processing or degradation under prolonged heat exposure. This observation aligns with findings by Gębczyński et al. (2024), which demonstrate how tannins can be reduced in high-heat treatments, thereby altering their impact on nutritional quality. While tannins are generally associated with reduced protein digestibility, they also contribute to antioxidant activity, indicating a trade-off when choosing preservation methods.

The antioxidant activity, as measured by the DPPH assay, was highest in fresh peas, followed by frozen, canned, and finally dried peas. This trend suggests that antioxidant compounds are highly susceptible to degradation through intensive processing. Drying, in particular, led to substantial reductions, with antioxidant activity in dried peas at only 8%, compared to 52% in fresh peas. This reduction may stem from the degradation of heat-sensitive antioxidants like vitamin C and polyphenols, as noted in the research by Ahmad & Eun (2018). Freezing was relatively effective in preserving antioxidants, likely due to the minimized exposure to heat and oxygen, making it an effective method for consumers interested in retaining the health benefits of antioxidants.

These findings have practical implications for both consumers and the food industry. For consumers, the study underscores the

nutritional advantages of consuming fresh peas when possible. Freezing emerges as a close alternative to fresh, particularly for retaining polyphenols, flavonoids, and antioxidants. Canning and drying, while convenient, lead to greater losses of essential nutrients and bioactive compounds, which may reduce the health benefits associated with pea consumption. For the food industry, these results suggest opportunities for optimizing preservation methods. Technologies like modified atmosphere packaging (MAP) and vacuum-sealing could further enhance nutrient retention in frozen and canned peas, as proposed by Kader (2002).

Furthermore, there is potential to improve drying processes through gentler techniques, such as freeze-drying, which may better preserve antioxidants and polyphenols compared to traditional air-drying. Future research should explore these alternative methods to offer consumers preserved peas that retain a closer nutritional profile to fresh peas.

While this study provides valuable insights into the impact of preservation on the nutritional quality of peas, it also highlights some limitations. The scope was limited to a single local pea population from Tunisia, which may affect the generalizability of findings to other pea varieties or geographic locations. Additionally, only a few bioactive compounds were analysed. Future research should consider a broader range of nutrients, such as vitamins B and K, and assess different pea varieties to gain a more comprehensive understanding of how preservation methods impact pea nutrition.

Overall, these findings emphasize the importance of choosing appropriate conservation methods to maintain nutritional quality. They provide a basis for consumers and producers to make informed decisions on preserving peas with maximum nutritional benefits.

5. CONCLUSIONS

In conclusion, the study highlights that fresh peas possess superior nutritional quality compared to their frozen, canned, and dried counterparts. It is recommended to consume fresh peas promptly after harvesting to maximize their nutritional benefits. Preservation methods such as freezing and canning can significantly impact the nutrient content, particularly proteins, polyphenols, flavonoids, and antioxidant activity. Factors like temperature, light, and air exposure also play a

crucial role in the deterioration of vitamins and other nutritional components. Thus, understanding the effects of different preservation states is essential for maintaining the nutritional value of peas. As perspectives we will consider developing the following axes: improving the quality of our products within the Conserve Company, and promoting the conservation of local pea populations.

Acknowledgment

The authors would like to thank the technical staff of the Institute of Arid Regions of Medenine (IRA), for their support in carrying out these experiments.

REFERENCES

- Ahmed, M., & Eun, J.-B. (2018). Flavonoids in fruits and vegetables after thermal and non thermal processing: A review. *Critical Reviews in Food Science and Nutrition*, 58 (18), 3159-3188. <https://doi.org/10.1080/10408398.2017.1353480>
- Albornoz, K., Pérez, C., Campos, P. (2021). Enhancing the retention of nutritional quality in peas through blanching before freezing. *Journal of Food Preservation* 45(3), 762-775. <https://doi.org/10.1111/jfpp.15549>
- Aude Coulombel. (2008). Analysis of Preservation Techniques for Harvested Products. *Journal of Agricultural Science* 123(4), 567-575.
- Bonoli, M., Verardo, V., Marconi, E., Caboni, M. F. (2004). Antioxidant phenols in barley (*Hordeum vulgare* L.) flour: comparative spectrophotometric study among extraction methods of free and bound phenolic compounds. *Journal of Agricultural and Food Chemistry* 52(16), 5195-5200.
- Bozin, B., Mimica-Dukic, N., Samojlik, I., Jovin, E. (2008). Antimicrobial and antioxidant properties of rosemary and sage (*Rosmarinus officinalis* L. and *Salvia officinalis* L., *Lamiaceae*) essential oils. *Journal of Agricultural and Food Chemistry* 55(19), 7879-7885. <https://doi.org/10.1021/jf0715323>
- Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical Biochemistry* 72(1-2), 248-254. [https://doi.org/10.1016/0003-2697\(76\)90527-3](https://doi.org/10.1016/0003-2697(76)90527-3)
- Brand-Williams, W., Cuvelier, M. E., Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT - Food Science and Technology* 28(1), 25-30. [https://doi.org/10.1016/S0023-6438\(95\)80008-5](https://doi.org/10.1016/S0023-6438(95)80008-5)
- Broadhurst, R. B., Jones, W. T. (1978). Analysis of condensed tannins using acidified vanillin. *Journal of the Science of Food and Agriculture* 29(9), 788-794. <https://doi.org/10.1002/jsfa.2740290908>
- Chen, P., McGee, R. J. (2016). Nutritional quality and health benefits of peas (*Pisum sativum* L.): A review. *Journal of Food Science* 81(10), R2447-R2453. <https://doi.org/10.1111/1750-3841.13456>
- Dewanto, V., Wu, X., Adom, K. K., Liu, R. H. (2002). Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. *Journal of Agricultural and Food Chemistry* 50(10), 3010-3014. <https://doi.org/10.1021/jf0115589>
- Eugenio, E., Sánchez, E., García, P. (2012). Use of DPPH method for determination of antioxidative activity of sewage sludge amended soil. *Journal of Environmental Management* 95(Suppl), S299-S302. <https://doi.org/10.1016/j.jenvman.2010.10.043>
- FAO (Food and Agriculture Organization of the United Nations). (2011).
- Fernandez-Agullo, A., Pereira, E., Freire, M. S., Dominguez, H., Gordon, M. H. (2010). Influence of solvent on the antioxidant and antimicrobial properties of walnut (*Juglans regia* L.) green husk extracts. *Industrial Crops and Products* 32(3), 622-627.
- Gurdip, S., Meena, R., Kaur, A. (2018). Vacuum sealing and refrigeration: Effective techniques for preserving protein quality and antioxidant levels in peas. *Food Chemistry* 241, 223-229. <https://doi.org/10.1016/j.foodchem.2017.08.013>
- Gębczyński, P.; Tabaszewska, M.; Kur, K.; Zbylut-Górska, M.; Słupski, J. (2024). Effect of the Drying Method and Storage Conditions on the Quality and Content of Selected Bioactive Compounds of Green Legume Vegetables. *Molecules*, 29, 1732. <https://doi.org/10.3390/molecules29081732>
- Jain, N., Chattopadhyay, R. (2016). Preservation of nutritional profile of peas through controlled atmosphere storage. *Postharvest Biology and Technology* 118, 109-115. <https://doi.org/10.1016/j.postharvbio.2016.04.004>
- Jiang, H., Tong, T., Sun, J., Xu, Y., Zhao, Z. (2014). Effect of drying methods on the

- physicochemical properties and antioxidant activities of pea protein isolates. *Journal of Food Science* 79(6), C906-C912. <https://doi.org/10.1111/1750-3841.12470>
- Kader, A. A. (2002). Modified atmosphere packaging of fruits and vegetables. *Journal of Food Science* 67(9), 2642-2648. <https://doi.org/10.1111/j.1365-2621.2002.tb08772.x>
- Ksouri, R., Megdiche, W., Falleh, H., Trabelsi, N., Boulaaba, M., Smaoui, A., Abdelly, C. (2007). Antioxidant and antimicrobial activities of the edible medicinal halophyte *Tamarix gallica* L. and related polyphenolic constituents. *Food and Chemical Toxicology* 45(4), 934-941. <https://doi.org/10.1016/j.fct.2006.11.002>
- Landau, S., Azaizeh, H., Muklada, H. (2000). The influence of condensed tannins in young leaves of *Ceratonia siliqua* (Carob) on the digestion of starch and nitrogen in sheep. *Journal of Agricultural Science* 135(1), 125-132. <https://doi.org/10.1017/S002185969900808X>
- Lara, S.W., Tsiami, A. (2024). A Lexicon of Descriptive Sensory Terms for Peas (*Pisum Sativum* L.): A Systematic Review. *Foods* 13, 1-20. Doi:10.3390/foods13142290.
- Leong, L. P., Shui, G. (2002). An investigation of antioxidant capacity of fruits in Singapore markets. *Food Chemistry* 76(1), 69-75. [https://doi.org/10.1016/S0308-8146\(01\)00251-5](https://doi.org/10.1016/S0308-8146(01)00251-5)
- Llorca, E., Redondo-Solano, M., Villalobos-Carvajal, R. (2020). Effect of drying methods on the nutritional quality of vegetables. *Food and Nutrition Sciences* 11(9), 679-695.
- Makris, D. P., Rossiter, J. T. (2001). Domestic processing of onion bulbs (*Allium cepa*) and asparagus spears (*Asparagus officinalis*): Effect on flavonol content and antioxidant status. *Journal of Agricultural and Food Chemistry* 49(7), 3216-3222. <https://doi.org/10.1021/jf001458x>
- Manach, C., Scalbert, A., Morand, C., Rémésy, C., Jiménez, L. (2004). Polyphenols: Food sources and bioavailability. *The American Journal of Clinical Nutrition* 79(5), 727-747. <https://doi.org/10.1093/ajcn/79.5.727>
- Rachel Burch. (2010). Nutritional Quality of Fruits and Vegetables and Its Relation to Human Health. *Nutrition Reviews* 68(1), 1-8.
- Loregian, K.E.; Pereira, D.A.B.; Rigon, F.; Magnani, E.; Marcondes, M.I.; Baumel, E.A.; Branco, R.H.; Del Bianco Benedeti, P.; Paula, E.M. (2023). Effect of Tannin Inclusion on the Enhancement of Rumen Undegradable Protein of Different Protein Sources. *Ruminants*, 3, 413-424. <https://doi.org/10.3390/ruminants3040034>
- Singh, P., Sharma, A., Kumar, R. (2020). Freezing versus canning: Impact on vitamin C content in peas. *Food Science and Nutrition* 8(6), 2975-2982. <https://doi.org/10.1002/fsn3.1608>
- Singleton, V. L., Orthofer, R., Lamuela-Raventós, R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology* 299, 152-178. [https://doi.org/10.1016/S0076-6879\(99\)99017-1](https://doi.org/10.1016/S0076-6879(99)99017-1)
- Van Der Poel, M. W. G., Tijsskens, L. M. M., Schouten, R. E. (2017). The role of humidity control in the storage of peas: Preserving essential vitamins. *Postharvest Biology and Technology* 130, 94-102. <https://doi.org/10.1016/j.postharvbio.2017.04.001>
- Wang, Y., Wang, J., Li, B. (2019). Low-temperature storage and nutrient preservation in peas. *Journal of Food Quality* 42(1), e12943. <https://doi.org/10.1155/2019/12943>
- Wang, Y., Zhang, H., Lu, L. (2020). Impact of drying methods on the nutritional quality and antioxidant activity of peas. *Food Chemistry* 320, 126641.
- Whent, M.M.; Childs, H.D.; Ehlers Cheang, S.; Jiang, J.; Luthria, D.L.; Bukowski, M.R.; Lebrilla, C.B.; Yu, L.; Pehrsson, P.R.; Wu, X. (2023). Effects of Blanching, Freezing and Canning on the Carbohydrates in Sweet Corn. *Foods*, 12, 3885. <https://doi.org/10.3390/foods12213885>
- Xie, J., Liu, Z., Wang, Z. (2018). Effects of different freezing methods on the quality of frozen peas. *Journal of Food Quality* 41(4), 1-8.
- Zhang, Y.; Meenu, M.; Yu, H.; Xu, B. (2020). An Investigation on Phenolic and Antioxidant Capacity of Under-utilized Food Legumes Consumed in China. *Foods*, 9, 438. <https://doi.org/10.3390/foods9040438>