Biological and Environmental Sciences Journal for the Tropics
Volume 21, Number 3, December 2024. Pp 192 - 196
DOIhttps://dx.doi.org/10.4314/bestj.v21i3.17

Research article

Effect of temperature regimes on the nutritional value of *Thymus vulgaris* (thyme)

***Rabe, A. M. and R. Apeh**

Department of Biological Science, Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria

E-mail: amina.musa@udus.sok.edu.ng

Submission: 11/08/2024
Accepted: 22/11/2024

Abstract
Thymus vulgaris (Thyme) is a perennial plant that grows as an herb in almost all regions. It is an aromatic spice and medicinal plant used for culinary. In this study, the effect of two different temperatures on the phytochemicals and nutritive content of *Thymus vulgaris* was determined. The study was conducted at Usmanu Danfodiyo University, Sokoto main campus. The sample of the thyme spice was collected from Sokoto Central Market and was dried under normal room temperature (27 ^{o}C) and high temperature (100 ^{o}C). Proximate and phytochemical analysis of the thyme sample was assessed for the presence of carbohydrates, protein, fibres, ash, alkaloids, saponin and tannins. The results reveal the presence of carbohydrates, protein, and ash under all the two temperatures. While a slight change was observed in the moisture content. Alkaloid was not detected under room temperature but its presence was observed under high temperature. Moreover, tannin is present under room temperature but when subjection to high temperature it was absent. This shows that temperature has an impact on the volatile compounds and phytochemicals of thyme. Further research should be conducted on different temperatures.

Key: *Thymus vulgaris;* Thyme; Room Temperature; Proximate; Phytochemical

Introduction

Thymus vulgaris *(*Thyme) is an herb widely used in African dishes as a spice and in traditional medicine. The herb is popularly known for its herbal remedies. It is mostly used either as a spice for culinary or medicinal uses for the treatment of ailments such as respiratory and gastrointestinal problems (Angélica *et al*., 2020, Mandal and DebMandal, 2016). It is indeed the most important species widely used as a flavouring agent, a culinary herb and as a herbal medicine. Thyme has a distinct smell. The flower, leaves and oil are used to flavour foods and also used as medicine. The thyme leaves are mostly used for providing flavour, aroma, and preservation to meat and fish (Al-Badr, 2011). The leaves are used fresh and dried or extracted for the flavouring oil. The major constituent is thymol but there appear to be other constituents of the oil which are carvacrol and flavonoids (Hudaib *et al*., 2002). Thyme has antibacterial, antifungal and antioxidant properties (Borugă *et al*., 2014; Jafri and Ahmad, 2019). It is also valued for its antiseptic and anti-oxidant properties.

During the processing method, in most cases, it is subjected to high temperature by either cooking or heating. This has a great impact on the quality of the thyme because most of the nutritional content present is altered (Yuan et al., 2009). Heat treatment at high temperatures affects the volatile oils, thymol and carvacrol which decrease due to degradation and evaporation. Some of the chemical constituents and volatile oils decrease due to evaporation (Chamber *et al*., 2020). The nutrition contents such as carbohydrates, protein, vitamins, and minerals are not much affected; they remain relatively stable but the moisture content is affected. Therefore, understanding the effect of temperature is essential in optimizing the necessary conditions to preserve the nutritional value and phytochemical content of thyme. This study shows the effect of temperature on the nutritional value and phytochemical composition of thyme spices.

Herbal medicines have some quality issues as compared with conventional medicines, mainly due to the variety of chemical compounds found in plants. Availability of these compounds depends on the nature of the plants, environmental factors, genetic factors, processing, drying, storage and extraction process. All these factors can modify the composition of these compounds, directly affecting their safety and efficacy (Argenta *et al*., 2011). Environmental factors, postharvest management and storage period are pivotal to the quality and production of these active compounds. In the processing method of the plant, desirable and undesirable changes occur in the plant composition for nutritive and phytotherapeutic uses. Thus, determining the suitable temperature for medicinal species is important for retaining the chemical composition at a desirable level (Silva *et al*., 2010).

Although, environmental condition plays a great impact on the quality of medicinal plants and food in general. The processing of plant material by drying and other processing methods either utilizing exposing the plant part to extreme temperature affects the nutritive content and the volatile compounds present in the plant; this reduces the food and medicinal quality of the plant. In most cases, when a plant material is subjected to high temperature and solar radiation the nutritive content is lost. In this research work, the aim is to analyze the effect of temperature on the quality of phytochemicals and nutritive content of *Thymus vulgaris*. The objectives are to determine the effect of temperature on the nutritive and phytochemical constituents of *Thymus vulgaris*.

Materials and Methods

Study Area:

The study was conducted at the Physiology laboratory Department of Plant Science of Usmanu Danfodiyo University, Sokoto.

Sample collection

A thyme sample was collected from the central market, Sokoto, Nigeria. The sample was conveyed to the herbarium of Usmanu Danfodiyo University, Sokoto for authentication and the voucher number (UDUH/ANS/0872) was deposited in the herbarium,

Preparation and treatment of thyme

The thyme sample was washed with distilled water and then dried under shade for one week. The dried sample was then package and stored in a sterilized polythene beg for further analysis. The sample was then pulverized using mortar and pestle. The powder was sieved using 80 µm laboratory sieves and then kept in a dried polythene bag for subsequent screening of chemical constituents.

The pulverized samples were subjected to two different treatments (room temperature and boiling point). The first set of the treatment was the sample of thyme and distilled water and was allowed to stand for two hours at room temperature (27 ^{o}C). While the other treatment was boiled under a temperature of 100 ^{o}C. After boiling, the sample was allowed to cool. Thereafter all the two treatments were subjected to proximate and phytochemical analysis.

Qualitative and Quantitative Analysis of Phytochemical of the Thyme

Qualitative and quantitative screening of phytochemicals of the thyme sample was conducted in the Biochemistry Laboratory, Usmanu Danfodiyo University, Sokoto. Quantitative test was conducted (Harbone, (1973; Sofowora, 1983; El–Olemyl *et al*., 1994) as modified by Amina *et al*. (2013). The extracts were evaluated for the presence of alkaloids, flavonoids, glycosides, saponins, and tannins.

Proximate analysis

The nutritive content of thyme under room temperature and high temperature was determined. The carbohydrate, protein, fibres and moisture content of the thyme were determined (El-Olemyi *et al.*, 1994; Amina *et al*. 2013).

Results and discussion

The indicated that alkaloids were not present at room temperature but were present after subjecting the sample to high temperatures (Table 1 and 2) This could be due to time taken is not enough to extract alkaloid or high temperature best extract alkaloid compound. Almostafa and Adam (2019) reported trace of alkaloids at high temperature. Initially the result indicated presence of Tannin at room temperature and later absent after subjecting

the sample to high temperature. Excess heat or temperature can alter the structure of phytochemical compounds by elimination or addition of a functional group. According to Piga (2007), when low temperatures are used, the loss of volatile compounds is low. In this experiment, the total phenolic acid content increased at low temperatures, while total flavonoid content decreased. Swieca and Baraniak (2014) reported that exposure to lentil sprouts at 4 °C for 1 hour increased the total phenolic and flavonoid contents and that low temperature can be an effective trigger for phytochemicals accumulation (Šamec *et al*., 2018; Šamec *et al*., 2022). Direct comparison of total polyphenolic compounds in broccoli and arugula sprouts grown at different temperatures (10 °C, 20 °C, and 30 °C) revealed a different trend; in broccoli, total polyphenolic compounds increases with higher temperature, while in arugula, they were highest at 10 °C and decreased with higher temperatures (Sameer *et al*., 2022). Changes in polyphenolic compounds at low temperatures probably depend on plant species/cultivars, their cold tolerance and growth stage (Sharma *et al*., 2019). In a study conducted by Ljubei *et al*. (2016) on the total glucosinolate content of Kale plants showed an increase at lower temperatures, which is consistent with the present study.

Table 1: Phytochemical screening of Thyme under two temperature conditions.

Parameters	Room Temperature (27 ºC)	High Temperature (100 ºC)
Alkaloids	-	+
Flavonoids	+	+
Glycosides	-	-
Saponins	+	+
Tannis	+	-

Key: + = Not detected; - = Detected

Table 2: Phytochemical analysis of Thyme under room temperature and boiling point

Parameters	Room Temperature	High Temperature (Boiling point)
Alkaloids	00.00	9.28
Flavonoids	13.26	8.15
Glycosides	00.00	0.00
Saponins	189.86	4.03
Tannis	61.24	0.00

Table 3: Proximate analysis of Thyme under room temperature and boiling point

Parameters	Room Temperature (27 ºC)	High Temperature (Boiling point)(100 ºC)
Ash content	06.00	06.00
Carbohydrate	61.76	61.76
Fibre	16.50	16.50
Lipid	05.50	05.50
Moisture content	03.50	04.65
Proteins	06.74	06.74

Spices and herbs are sensitive to temperature, moisture and oxygen. When temperature increases, it leads to the loss of essential oils. Low temperature helps in obtaining good organoleptic properties and a short processing time. On the contrary, the high temperature and processing method of the extract in the period of boiling gives a chance for obtaining alkaloids which was absent at low temperatures in the present study. Low temperature leads to excellent production of quality compounds (Ratti, 2001). Some of the important chemical constituents are high in a low-temperature sample (freezing) (Urbashi, and Beta (2020) when compared to samples subjected to

high temperatures even though the temperature of the present study is higher than the study conducted by Ratti (2001).

Loss of colour, dryness, burns and tissue softening may have occurred due to enzymatic action, which occurs more rapidly at higher temperatures. Wang *et al*. (2016) evaluated the antibacterial activity in the liquid and vapour phase of thymol and other phenolic compounds against oral pathogens under different conditions of temperature and pH showed that the thymol is stable at room temperature in both liquid and vapour phases, but decreases at temperatures < 80 °C. This could be due to the presence of thymol as the most active constituent in the thyme at room temperature.

Conclusion

This work showed that temperature affects the quality of *Thymus vulgaris* a medicinal plant at both low and high temperatures. Some of the chemical compounds are available at low temperatures while some are found present and available only at high temperatures. Therefore, there is a need to analyse other chemical class such as flavonoids and phenolic compounds presence in the *Thymus vulgaris* using gas chromatography Mass spectroscopy, and Fourier-transform infrared (FTIR) spectroscopy, and determination of antioxidant activity of thyme using different alcoholic solvents and temperatures is worthy.

References

Amina, R. M., Aliero, B. L. and Gumi, A. M. (2013). Phytochemical screening and oil yield of a potential herb, camel thyme (*Cymbopogon schoenanthus* Spreng.). *Central European Journal of Experimental Biology*, 2 (3):15-19 (http://scholarsresearchlibrary.com/archive.html)

Argenta S. C, Argenta L. C, Giacomelli S. R and Cezarotto V. S. (2011). Plantas medicinais: cultura popular versus ciência. Vivências 7: 51-60.

Angélica Escobar, Miriam Pérez, Gustavo Romanelli and Guillermo Blustein (2020). Thymol bioactivity: A review focusing on practical applications, *Arabian Journal of Chemistry*, Volume 13, Issue 12, Pages 9243-9269, ISSN 1878-5352, https://doi.org/10.1016/j.arabjc.2020.11.009.

Borugă, O. C. Jianu, C. Mişcă, I. Goleţ, A.T. Gruia, F.G. Horhat (2014). *Thymus vulgaris* essential oil: chemical composition and antimicrobial activity. *Journal of Medical and Life*, 7 (3), pp. 56-60

Chambre DR, Moisa C, Lupitu A, Copolovici L, Pop G, Copolovici DM. Chemical composition, antioxidant capacity, and thermal behavior of Satureja hortensis essential oil. Sci Rep. 2020 Dec 7;10(1):21322. doi: 10.1038/s41598-020-78263-9. PMID: 33288856; PMCID: PMC7721874.

El–Olemyl, M. M., J. A. Fraid, and A.A. Addle Fattah, (1994). Experimental Phytochemistry. *Laboratory Manual Afifi,* Abdel Fatah king Saudi University, 310.

Hudaib, M., E. Speroni, A. M. Di Pietra and V. Cavrini (2002). GC/MS evaluation of thyme (Thymus vulgaris L.) oil composition and variations during the vegetative cycle. *Journal of Pharmaceutical and Biomedicinal Analysis*, 29, pp. 691-700, 10.1016/S0731-7085(02)00119-

Harbone, J. B. (1973). Phytochemical methods: A guide to modern techniques of plant analysis. Chapman and Hall, London, 2 nd edition, 1-13.

Jafri H. and Ahmad, I. (2019). *Thymus vulgaris* essential oil and thymol inhibit biofilms and interact synergistically with antifungal drugs against drug resistant strains of *Candida albicans* and *Candida tropicalis*. *Journal of Mycology Med*., 100911 (2019), 10.1016/j.mycmed.2019.100911

Ljubej, V.; Radojčić Redovniković, I.; Salopek-Sondi, B.; Smolko, A.; Roje, S.; Šamec, D. (2016). Chilling and freezing temperature stress differently influence glucosinolates content in *Brassica oleracea* var. *acephala*. *Plants*, *10*, 1305. [**Google Scholar**] [**CrossRef**] [**PubMed**]

Mandal S. and M. DebMandal (2016). Thyme (*Thymus vulgaris* L.) oils A. Press (Ed.), Essential Oils in Food Preservation, Flavor and Safety, *Elsevier* Inc., London, pp. 825-834, 10.1016/B978-0-12-416641-7.00094-8

Piga A., Usai M., Marchetti M., Foddai, M., Dei, CaroA., meiler H. P., Onorati V., and Vinci F. (2007). Influence of different Drying parameters on the composition of volatile compounds of Thyme and Rosemary cultivated in sardine. *International Symposium on Food and agricultural products: processing and Innovation*, Naples Italy. 1-2.

Ratti C. (2001). Hot air and freeze-drying of value foods: A- Review. *Journal of food Engineering*. 49(4), 311-319.

Šamec, D.; Pavlović, I.; Radojčić Redovniković, I.; Salopek-Sondi, B. (2018). Comparative analysis of phytochemicals and activity of endogenous enzymes associated with their stability, bioavailability and food quality in five Brassicaceae sprouts. *Food Chem.* **2018**, *269*, 96–102.

Šamec, D.; Ljubej, V.; Redovniković, I.R.; Fistanić, S.; Salopek-Sondi, B. (2022). Low Temperatures Affect the Physiological Status and Phytochemical Content of Flat Leaf Kale (*Brassica oleracea* var. *acephala*) Sprouts. *Foods* **2022**, *11*, 264. https://doi.org/10.3390/foods11030264

Sharma, A.; Shahzad, B.; Rehman, A.; Bhardwaj, R.; Landi, M.; Zheng, B. Response of phenylpropanoid pathway and the role of polyphenols in plants under abiotic stress. *Molecules* **2019**, *24*, 2452.

Silva F. G., Nascimento V. E., Pinto J. E. B. P., Oliveira C. B. A., Santos M. R. and Ferri P. H. (2010). Influência do processamento pós-colheita e armazenamento na composição química da droga vegetal e do óleo essencial de carqueja [Baccharis trimera (Less.) DC.].*ss* 12: 436-442.

Sofowora, A. (1993). African Medical Plants, University of Ife, Nigeria, 38-70

Świeca, M.; Baraniak, B. Nutritional and antioxidant potential of lentil sprouts affected by elicitation with temperature stress. *Journal of Agriculture and. Food Chemistry.* **2014**, *62*, 3306–3313.

Urbashi, H. and Beta G. (2020). Lyophilisation and its effects on the essential oil aqn spices. A- Review. *Acta Scientiarium Polonorium Technolia*. Issue 19(4) 467-473.

Wang, T. H. , S. M. Hsia, C. H. Wu, S.Y. Ko, M.Y. Chen, Y. H. Shih, T.M. Shieh, L. C. Chuang and C.Y. Wu (2016). Evaluation of the antibacterial potential of liquid and vapor phase phenolic essential oil compounds against oral microorganisms *PLoS ONE*, 11, pp. 1-17, 10.1371/journal.pone.0163147\

Yuan GF, Sun B, Yuan J, Wang QM. Effects of different cooking methods on health-promoting compounds of broccoli. J Zhejiang Univ Sci B. 2009 Aug;10(8):580-8. doi: 10.1631/jzus.B0920051. PMID: 19650196; PMCID: PMC2722699.