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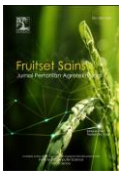

STUDY ON THE AMINO ACID COMPOSITION OF CRUDE FICIN ENZYME FROM *Ficus padana Burm.f.* USING SOLAR DRYING

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Abstract

Ficin is an enzyme derived from Ficus sp., recognized for its applications in the food and pharmaceutical sectors. Utilizing solar energy for enzyme drying has been shown to be economical and environmentally sustainable while preserving enzyme activity. This study aimed to determine the amino acid composition of crude ficin from Ficus padana Burm. f., and was extracted and dried with solar energy. The analysis of amino acid components was conducted using the UPLC technique. The results indicated the presence of numerous important amino acids, with L-aspartic acid being the highest concentrated at 1.85 mg/g and L-leucine at 1.41 mg/g. Significant quantities of L-glutamic acid (1.33 mg/g), L-serine (1.14 mg/g), and L-lysine (1.05 mg/g) were also identified. The solar drying process showed no significant loss of amino acids. The findings suggest that solar drying does not negatively impact the amino acid composition in fiction, therefore enhancing its practical significance, particularly for the food and pharmaceutical sectors.

Keywords: Ficin enzyme, Ficus padana Burm.f., Solar Drying, Crude Enzyme, Amino Acid Profile

1. Introduction

Ficin and other protease enzymes are essential in cleaving peptide bonds found in proteins and hence find applications in food processing, pharmaceuticals, and cosmetics industries. Ficin is a proteolytic enzyme that can be obtained from the latex of different Ficus plants, most notably from Ficus carica. Since he can degrade proteins, he has potential applications in meat tenderizing, cheese making, and even medicine (Destryana et al., 2023). Despite its great potential, ficin is often undermined by its instability as an enzyme since it can quickly lose its activity in storage and transportation, limiting its more comprehensive perspective application (Wei et al., 2023).

Drying is a standard method that is done in order to improve the storage and usability of enzymes. Drying also increases the shelf life of the enzymes and allows better transport and storage of the enzymes (Anab-Atulomah & Nwachukwu, 2021). However, proper control of the drying conditions needs to be conducted so that the protein structure of the enzyme will not be denatured and the enzyme activity is preserved. Conventional methods such as freeze-drying and spray-drying are very common in their application; however, they entail high capital and energy requirements, which could be a limitation in developing countries (Mongkolpathumrat et al., 2022). Conversely, solar drying is cheap and friendlier to the environment. It utilizes readily available solar energy making it effective in areas where sunshine is abundant, like the tropics (Boo et al., 2013). The main benefits of solar drying are that the operational expenses are low, and it can lower carbon emissions compared to other drying techniques that are energy-intensive (Costa-Silva, Souza, Said, & Oliveira, 2015). These benefits notwithstanding, the effects of solar drying on the quality of the enzyme, its amino acid structural components, and enzyme activity have hardly been investigated (Hay, Johannissen, Hothi, Sutcliffe, & Scrutton, 2012).

Amino acids are structural units in proteins and enzymes and play an essential role in the stability of these enzymes and their catalytic activity. Amino acids like glutamate, serine, lysine, and leucine are essential drugs that assist protein and enzymatic catalysis (Hansen et al., 2019). This, in combination with some of the findings in the literature, indicates that any changes in the amino acid composition due to the drying processes may significantly affect the enzymatic performance. The significance of the research and analysis on the impact of drying methods on the various amino acids of fiction is such that different methods of drying do not destroy important constituents of the enzyme which are important for activity (Toouli et al., 2010).

This study aims to evaluate the potency of the crude ficin enzyme sourced from Ficus carica ovaries with a solar drier. The study seeks to dry ficin wet with the objective of assessing its potential industrial enzyme utility through its stability. Furthermore, the results obtained from this work will equally enhance the use of the solar drying technique so that the quality and activity of the enzyme will not be affected as other methods of enzyme production would have done ((Wagner et al., 2017). Some recent studies draw attention to the importance of stability and activity of proteases for various applications, e.g., for the development of protease inhibitors for therapeutics (Mongkolpathumrat et al., 2022) and for devising protease-producing technologies (Anab-Atulomah & Nwachukwu, 2021). The importance of proteases in various biotechnological applications continues to grow, and so does the demand for investigations into enzyme stability management (Destryana et al., 2023; Wei et al., 2023).

2. Materials and Methods

The tools used in this study are sap tapping tools, centrifuges, and other laboratory instruments. The materials utilized in this research were latex of fig plants species of *Ficus padana Burm.f.*, aquades, filter paper, NaN_3, and other chemical component used in amino acid analysis.

2.1 Collection of latex

Latex from the fresh fig was harvested by snapping off the twigs of the *Ficus padana Burm f.* tree grown in Limau manis Padang inside a clean tube with 0.05% NaN_3. All the latex samples used in this study were obtained in the early morning. The latex fluid was then transported to the laboratory under suitable conditions and held at – 20°C until required.

2.2 Preparation of crude extract

The frozen latex was kept at 4°C until it thawed and afterwards, it was diluted with 1.0:0.5 water:latex ratios, thoroughly mixed and then centrifuged at 5000 rpm for 15 minutes at 4°C to remove gum and other debris. The residue was removed and the supernatant was treated with Whatman paper No. 1 for filtration. The clear juice termed “crude extract” was used (Gagaoua et al., 2014). The crude extract was uniformly distributed over a glass plate. Subsequently, it was desiccated in a solar drying chamber for 8 hours. The latex was desiccated until it crystallized into brownish-white.

2.3 Amino Acid Analysis

The analysis method of amino acid components was carried out in the PT. Saraswanti Indo Genetech Laboratory using UPLC (18-5-17/MU/SMM-SIG) method.

3. Results and Discussion

The assessment of the amino acids in the crude ficin enzyme obtained from *Ficus padana Burm.f.* after solar drying demonstrates the stability of enzyme and the understanding of the possible industrial uses of the enzyme. It can be concluded from the study objectives that the application of solar such as food processing techniques preserve the amino acid profile because the profile is critical to the other intended applications of the enzyme in biotechnology settings.

According to the post-solar drying analysis, a crude enzyme of the ficin type was found to have a high amount of L-Aspartic Acid 1.85 mg/g which plays a key role in the catalytic functions of the enzyme. According to (Aïder, 2021), aspartic acid is present in the active sites of proteases that catalyze the hydrolysis of peptide bonds, influencing enzymatic efficiency. Also, L-Leucine at 1.41 mg/g strongly supports the enzyme structural stability as Leucine as a branched-chain amino acid has been reported to provide thermoprotective effects during drying (Aïder, 2021). Further, high amounts of 1.33 mg/g of L-Glutamic Acid and 1.14 mg/g of L-Serine support this statement because these amino acids are vital components needed to stabilize the active site region of proteases and thus enhance the catalytic activities of enzymes (Aïder, 2021).

Table 1. Amino acid composition of crude ficin enzyme from *ficus padana Burm.f.*

Amino acid type	value (mg/g)
L-Serine	1.14±0.01
L-Glutamic acid	1.33±0.01
L-Phenylalanine	0.99±0.00
L-Isoleucine	0.84±0.00
L-Valine	0.66±0.00
L-Alanine	0.92±0.00
L-Arginine	1.06±0.01
Glycine	0.66±0.00
L-Lysine	1.05±0.01
L-Aspartic Acid	1.85±0.01
L-Leucine	1.41±0.00
L-Tyrosine	0.65±0.01
L-Proline	0.89±0.00
L-Threonine	1.13±0.01
L-Histidine	nd

nd = not detected

In more recent years, there has been an emphasis on the use of ficin and its derivatives. For example, (Mousavi Maleki et al., 2023) studied the proteolytic impact of ficin on gliadin cell and its potential use in food processing and the treatment of celiac disease. In addition, carboxymethyl cellulose-carboxylic fibrous material improved the proteolytic activity of ficin suggesting that these modifications might enhance its industrial relevance (Сорокин et al., 2023). Results from the current study seem to echo observations made by others, namely that solar drying does not reduce the enzyme activity to a level where it cannot be used in a variety of applications.

A crude ficin enzyme appears to have a specific ratio of essential to non-essential amino acids, suggesting that such an enzyme is still structurally sound enough to retain catalytic efficiency. Presence of non–essential amino acids like Glycine (0.66 mg/g) and aldehyde (0.92 mg/g) is important in carrier molecules and facilitating of catalytic reactions. L-Histidine might indicate a different catalytic pathway that utilizes other amino acids of

proteolytic properties such as aspartic and glutamic acid (Aïder, 2021). This finding suggests that more work should be done regarding the structural features of ficin when compared with other histidine-containing proteases.

Figure 1. *Ficus padana Burm.f.*

Due to its cost efficiency and eco-friendliness, solar drying is now recognized as a promising alternative for lodging the ficin enzyme. This has benefited the enzyme activity since, In contrast to other drying processes where high temperature is usually performed and may cause destruction of amino acids, ambient temperature and sunlight are used instead to dry products (Babar, Tarafdar, Malakar, Arora, & Nema, 2020; Boateng, 2023). Recent works promote the use of solar drying systems due to their ability to reduce the ecological effects of the drying process while at the same time improving the quality and nutritional value of the dried products (Boateng, 2023). These results are consistent with the findings of (Yayehrad, 2023), who covered the physicochemical characterization of ficus extracts and clarified its sustainable aspects related to using plant materials (Yayehrad, 2023).

These results of the research have repercussions on the industrial uses of ficin. The fact that amino acids are retained during solar drying and enzymatic activity indicate the possible application of ficin in the food sector for meat tenderization, cheese making, and bioactive peptides in the pharmaceuticals industry (Aïder, 2021). The preservation of enzymatic activity through solar drying forms the basis for advocates' position that ficin is becoming one of the most suitable enzymes for large-scale industrial use, especially within the contexts of developing nations, where environmental considerations for enzyme production are fundamental (Babar et al., 2020; Boateng, 2023).

In the case of this study, solar energy has been highlighted as the best harvesting technique for maintaining the amino acid profile and the activity of the crude ficin enzyme obtained from the *Ficus padana Burm. f.* plant. Based on the presence of certain amino acids in substantial quantities, it is reasonable to expect that the enzyme will be effective and useful in environmentally friendly industries. In the future, research should be conducted to optimise the solar drying techniques to enable greater productivity in the production of enzymes and examine the properties governing the enzymatic catalysis of ficin.

4. Conclusion

The amino acid profile of the ficin enzyme obtained from *Ficus padana Burm.f.* stem latex was shown in this paper to be stable even after treatment with solar heating. In any case, significant quantities of essential amino acids such as L-Aspartic acid, L-Leucine, L-Glutamic acid, and L-Serine were detected; this indicates good proteolytic activity in the dried form of the ficin enzyme. The methodology that employed solar energy in the drying process also shielded the amino acids from degradation without compromising enzyme structure, hence, it is environmentally friendly and cost-effective when compared to alternative methods. Furthermore, investigations into the enzyme's activity following extended storage or under different environmental circumstances might provide significant insights for its application in the food and pharmaceutical sectors.

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