Conference Paper

Drying Kinetics of *Curcuma xanthorrhiza* Roxb.

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Abstract

Curcuma xanthorrhiza Roxb. (giant curcuma) is one of herbal plants which is easily found in tropical region such as in Indonesia and has been widely used for medical purposes. This plant has been intensively used as the main ingredients of traditional medicines due to its potent healing power. Giant curcuma is generally dried using a conventional way under the sun prior to use. This method was less controlled, thus leading to poorer quality of products. Drying in a controlled batch dryer could improve product quality in overall. This experiment aimed to study the drying kinetics of giant curcuma using a laboratory designed batch dryer. Drying temperatures were varied between 40°C to 60°C. Samples were also dried in the oven at corresponding temperatures as the control. The drying was conducted until approximately 11 % dry basis moisture content inside the samples was achieved. In general, the drying time of giant curcuma were shorter when the temperatures were increased. This was also confirmed by Page's Model whereby drying rate constants increased four times both in the batch dryer as well as in the oven when the drying temperatures were increased from 40°C to 60°C.

Keywords: batch dryer; drying rate; diant curcuma; Page's Model.

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1. Main text

Herbs have been used by Indonesian for a long time ago as a medical alternative, for disease prevention, healing, rehabilitation, and for promoting health [1] since herbs contain biological active compounds and antioxidants so that they can as be used medicines with low side effects. Herbs used as medicines could be in the forms of rhizomes or leaves. The moisture contents of herbs used for medicinal purpose may not exceed 10 % water in wet basis or approximately 11 % dry basis [2].

Giant curcuma (*Curcuma xanthorrhiza* Roxb.) which is also known as Java Ginger or Javanese Ginger [3], has been intensively used as traditional medicines. This herb is easily found in Indonesia and has been one of important herbs because of its bioactive compound.

For medicinal purposes, giant curcuma must be properly dried for the initial use to reduce its bulky volume and increase the shelf-life. There are several common techniques for drying herbs in a more controlled way, such as drying using hot air and oven is mostly used to dry herbs. Both techniques are quite simple and not expensive. In this experiment, a self-designed batch dryer with varying hot air temperatures was used for drying the giant curcuma. A blower was used for the hot air circulation. The drying characteristics of the samples dried in batch dryer were compared with those dried in the oven. Furthermore, the drying kinetics of biological materials is essential for the design, optimization, and control of the drying process [4]. Therefore, the drying kinetics using Page's model was also studied.

2. Materials and methods

2.1. Raw materials

Giant curcuma (*Curcuma xanthorrhiza)* which is usually known as 'temulawak' was purchased from Jagir Local Market, Surabaya, Indonesia. At first, dust and dirt were manually removed out from the giant curcuma. Afterwards, it was horizontally sliced with the thickness of about 3 mm. Slices were collected and weighed using a balance (Mettler, Toledo) which had accuracy up to 0.1 mg prior to drying.

2.2. Instruments

Drying was conducted in the self-designed batch dryer and also in the oven (MMM Medcanter, Germany). The self-designed batch dryer was depicted in Fig. 1. It was equipped with a blower which has 500 VA capacity and regulator type 242,5M fabricated by Matsunaga MFG, co., LTD, Japan used to control the speed of hot air.

2.3. Drying process

The drying temperatures were set at 40°C; 50°C; 60°C both in the batch dryer and oven. During the experiments, RH (relative humidity) of the air was fluctuated between 30 % to 70 %. The hot air flow rate was set at 2.1 $m \cdot s^{-1}$ during the experiments using the batch dryer. Two slices of giant curcuma were put into the sample holder and placed in the dryer once the temperature inside the dryer was already steady. Samples were continuously weighed after a certain time until reaching a constant weight.

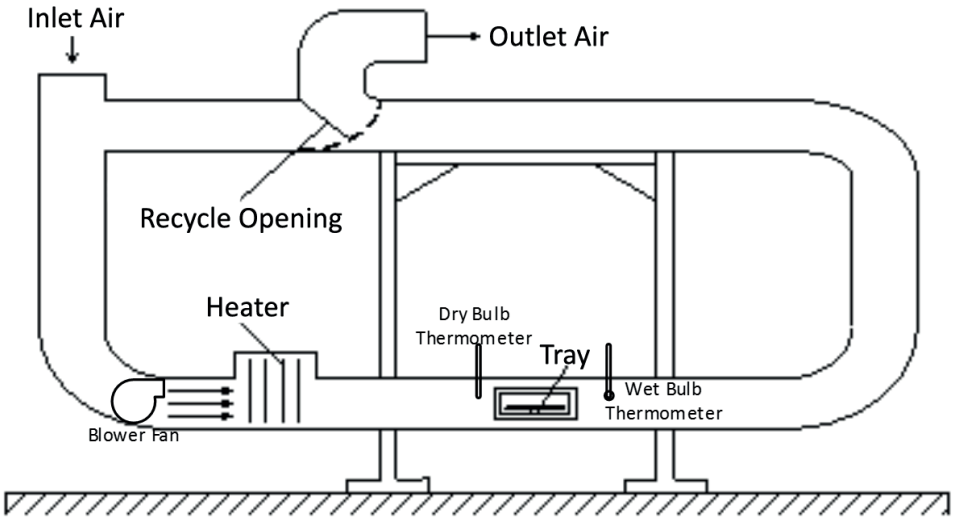

Figure 1: Self-designed batch dryer.

2.4. Data processing

Results were presented as drying characteristic curves whereby free moisture contents (X) were plotted versus the drying time [5]. Free moisture content was obtained from the subtraction of equilibrium moisture content (X*) from moisture content at certain time (X_t). The calculation of X_t and X could be seen in Equation (1) and Equation (2), respectively.

$$X_t = \frac{W_t - W_d}{W_d} \quad (1)$$

where X_t = moisture content at certain time (kg H_2O/kg dry weight); W_t = sample weight at certain time (kg); W_d = sample dry weight (kg) obtained from drying up the sample at 120°C for about 2 hours until the weight was constant.

$$X = X_t - X* \quad (2)$$

where X = free moisture content (kg H_2O/kg dry weight); X_t = moisture content at certain time (kg H_2O/kg dry weight); X* = equilibrium moisture content (kg H_2O/kg dry weight).

Furthermore, drying rate (R_c) was plotted against free moisture content (X) in order to study the constant rate zone and falling rate zone [5].

$$R_c = -L_s \frac{dX}{dt} \quad (3)$$

where R_c = drying rate (kg H_2O/min); Ls= sample dry weight (kg); dX/dt = rate of free moisture changes per time (kg H_2O/(kg dry weight.min)). The slope of Eq. (4) and Eq. (6) was determined yielding Eq. (5) and Eq. (7) for calculating dX/dt for constant rate

zone and falling rate zone, respectively. The data was processed using Microsoft Excel 2013 and Curve Expert Professional 2.3.0.

$$X = at + b \tag{4}$$

$$\frac{dX}{dt} = a \tag{5}$$

$$X_t = a \times \ln t + b \tag{6}$$

$$\frac{dX}{dt} = \frac{a}{t} \tag{7}$$

The loss of moisture content in wet basis could be calculated using Eq. (8).

$$Loss = 100\% - \frac{W_t - W_d}{W_i} \tag{8}$$

where W_t = giant curcuma weight in certain time (kg); W_d = dry solid weight (kg); and W_i = initial weight of giant curcuma (kg).

2.5. Mathematical modeling

According to the study of Ademiluyi et al. [6] and Tarigan et al. [7] drying kinetics were mathematically modeled using Page's Model of which equation is

$$MR = e^{-k.t^n} \tag{9}$$

where MR is ratio between free moisture content at certain time and initial free moisture content; k is drying rate constant in hour^{-1}, n is dimensionless constant from Page's Model, and t is drying time in hour.

3. Results and discussion

From the experiment, it was obvious that the drying time was getting shorter as the temperature was increasing both in the oven as well as in the batch dryer as can be seen in Fig. 2. The slopes were getting steeper as the increased temperatures indicating the higher drying rate with the increase of temperature. Similar findings have been reported by Jabeen et al. [8].

In general, drying process were occurred in two periods, i.e. constant rate period and falling rate period as could be more clearly seen in Fig. 3. In the constant-rate drying period, the surface of the solid was initially very wet and a continuous film of water existed on the drying surface [5]. This period continued as long as the water diffusion rate inside the pores to the surface was equal to the evaporation rate of water from

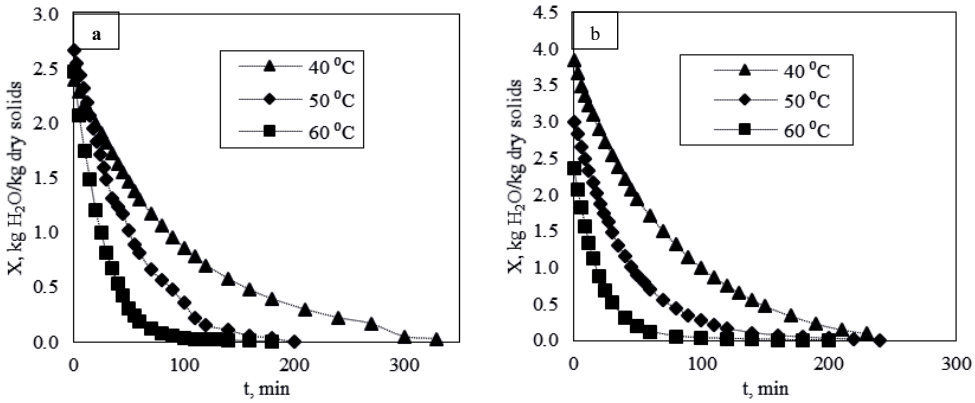

Figure 2: Free moisture content versus time at varying temperatures. (a) oven; (b) batch dryer.

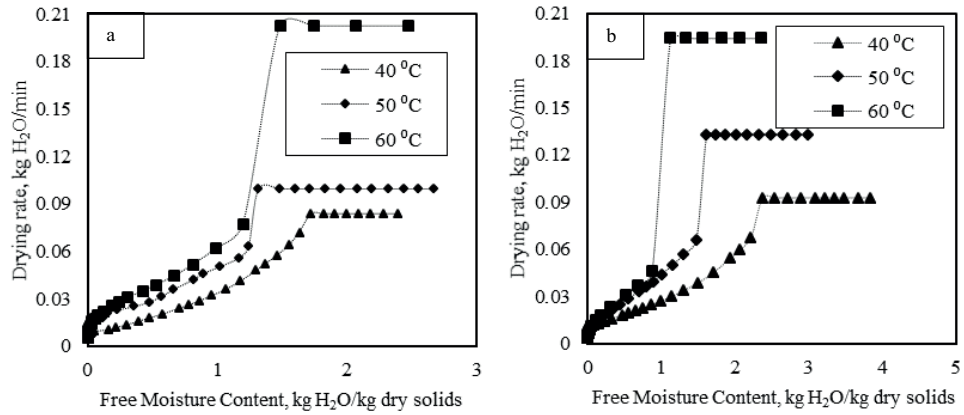

Figure 3: Rate of drying curve as rate versus free moisture content at varying temperatures. (a) oven; (b) batch dryer.

the surface to the air. The falling rate period just began when the entire surface was no longer wetted and the wetted area was continually decreasing until the surface was completely dry. It was also obvious from Fig. 3 that the constant drying rate (Rc) were higher as temperatures increased.

The increase of drying rate with the increase of temperature was also confirmed by empiric constant k derived from fitting the experimental data with Page's model (Fig. 4 and Table 1). The constant k which was related to drying rate was increased ~4 times when the temperature was increased from 40°C to 60°C both in the oven as well as in the batch dryer as could be seen in Table 1.

It was also clearly seen that drying kinetics in the batch dryer was faster than those in the oven. The value of k derived from drying process in the oven was about 25 % lower than the corresponding k obtained from the drying process conducted in the batch dryer. This was plausible since the convective heat transfer in the batch dryer was more improved due to the continuous hot air flowing throughout the sample, thus

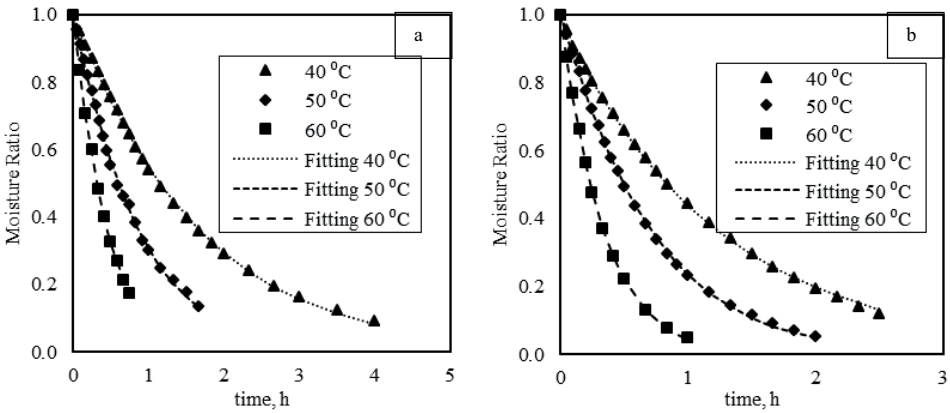

Figure 4: Fitting of experimental drying data using Page's Model. (a) oven; (b) batch dryer.

Dryer	Temperatures (°C)	Page's Model Parameter		
		k	n	r^2
Batch dryer	40	0.821	0.981	0.999 8
	50	1.442	1.064	0.999 8
	60	3.113	1.056	0.999 9
Oven	40	0.594	1.036	0.999 7
	50	1.174	1.072	0.999 2
	60	2.338	1.070	0.999 6

Table 1: Parameter of drying kinetic from Page's model.

enhancing the water vapor mass transfer from the sample to the hot air in contrast to the less dynamic air flow in the oven.

Finally, the total loss of moisture (wet basis) inside giant curcuma during drying process was shown in Table 2. In overall, all drying temperature could remove out more than 99 % moisture (wet basis) although the moisture loss was increased when drying temperature was increased. The final moisture content was lower when giant curcuma was dried at higher temperature. The moisture loss during drying in the batch dryer

Time (h)	Oven			Batch dryer		
	40 °C	50 °C	60 °C	40 °C	50 °C	60 °C
0	-	-	-	-	-	-
1	62.64	78.15	94.74	66.04	82.90	96.44
2	79.83	95.81	99.37	85.01	95.94	99.27
3	88.71	98.93	99.83	93.31	98.87	99.85
4	93.68	-	99.94	99.04	99.83	99.99
5	98.61	-	-	-	-	-
6	99.40	-	-	-	-	-
Dry basis, last moisture content	2.07	3.96	0.22	0.96	0.17	0.012

Table 2: Loss of Moisture during Drying (% wet basis).

especially within the first hour was higher in comparison to that in the oven. This was indicated by the much lower final moisture content dry basis of giant curcuma dried in the batch dryer. The color of the samples dried in the batch dryer was almost similar to that dried in the oven. However, the higher the temperature the less preserved the color of the giant curcuma was which might be related to the loss of the activity of their bioactive compounds. This experiment showed that the superior drying process conducted in the self-designed batch dryer in comparison to drying process conducted in the oven.

4. Conclusion

The drying process carried out in the self-designed batch dryer was more effective compared to that in the oven. It turned out that drying time required to dry the sample in the batch dryer was shorter due to its higher drying rates. The higher the temperature, the higher the drying rate and the shorter the time required to achieved the constant moisture content. The drying rate constants derived from fitting the experimental data with Page's model were four times higher when the drying temperatures were increased from 40°C to 60°C both in the batch dryer as well as in the oven.

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The 1st-International Conference on Natural Resources and Life Sciences – NRLS is organized by the Faculty of Biotechnology, University of Surabaya. The theme of this conference is set on the "Multidisciplinary Science for Better Achievement". The conference has facilitated the exchange of useful information on the life science and natural resources exploration practices for the future human needs, as well as to enlarge collaboration activities for the development of research and technology in natural resources and life science among academics and professionals in Europe and Asean. There were over 120 participants from countries and regions, such as Germany, Netherland, Nepal, Korea, Thailand, Malaysia and, of course, Indonesia.

Over 113 abstracts and presentations, there are 22 papers selected to be published in KnE Conference Proceeding, representing the for themes of 2016, *i.e.*: Food Biotechnology, Plant Biotechnology, Medical Biotechnology & Forensics, and Environmental Biotechnology & Renewable Energy. All 22 manuscripts in KnE Life Sciences vol. 2017 had been reviewed by experts from University of Groningen, University of Postdam, RWTH Aachen University, Kyung Hee University, Universiti Selangor, and University of Surabaya, Indonesia. The published papers have passed all necessary improvement according to the KnE standard and reviewer's comments. Our appreciation goes to the reviewers, editors and the whole Scientific and Editorial Board for their big effort in review and improvement process of the papers.

For the generous support provided in succeeding the NRLS-2016, we thank the following parties: The University of Surabaya's management and supporting units, DAAD (Deutschland Academische Austausch Dienst). Our Sponsors: SCIENCEWERKE, BIONEER, INDOLAB UTAMA, ENSEVAL MEDIKA PRIMA, MEGAH SEJAHTERA SCIENTIFIC and APD (ALUMNI PORTAL DEUTCHLAND). Last but not least, we thank you all presenters and attendees for the active participation. We hope all of us enjoyed this event and will always continue the collaborations and friendship, scientific exchange, development of joint projects that are of scientific and economic importance in order to explore the natural resources and life sciences in particular in the area of food, health,

agriculture, sustainable environment and renewable energy development. We hope you return next year with even more colleagues for NRLS 2018!

Dr. Popy Hartatie Hardjo

Executive Chief of NRLS-2016 Committee

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Conference Paper

Action Research into a Flood Resilient Value Chain – Biochar-Based Organic Fertilizer Doubles Productivity of Pea in Udayapur, Nepal

Anu Joshi Shrestha[1] and Bishnu Hari Pandit[2]

[1]International Centre for Integrated Mountain Development, Kathmandu, 3226, Nepal
[2]Kathmandu Forestry College (KAFCOL), Kathmandu, 9594, Nepal

Abstract

Green growth and flood resilient value chain development have been foremost in the minds of vegetable growers in six villages of Udayapur District when they agreed to join pea field trials for a self-made biochar based organic fertilizer. Like so many Nepalese women and men who depend on farming for their livelihoods their top concern was getting high crop yields while lowering their input costs. Farmers of six villages (240 migrant workers' families) are now showing how boosting agriculture productivity and saving costs at the farm level can go hand in hand with national climate change strategies particularly in replacing chemical fertilizers in tropical soils of Nepal, an Action Research project result revealed. The results demonstrated that the biochar based organic fertilizer has enhanced the nutrient efficiency by increasing yields of at least four vegetable crops (peas, bottle gourd, cauliflower, and tomato) in the study area, and this technology was found more resilient to adverse climate (flood and drought) conditions. The trials have further investigated that the combination of biochar and cow urine, a source of nutrients readily available to farmers, have increased fresh pea yields double folds from (3 to 7) $t \cdot ha^{-1}$ in off season (end of Dec. to Mar.). With this learning, a flood resilient pea value chain was developed, where farmers could get increase in income from 9.92 % (traditional value chain) to 44.32 % (upgraded value chain). Further benefits of biochar based organic fertilizer have been recorded with increase of soil organic matter content in the root zone of crops and soil moisture content.

Keywords: biochar based organic fertilizer; chemical fertilizer; flood resilient value chain, fresh green Pea, migrant workers' family; yield.

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1. Introduction

There is a significant gap between current and potential agricultural production in Nepal. The low levels of productivity are the result of several factors including a high level of subsistence farming, low level of access to and adoption of suitable improved technologies (both on farm and post harvest), poor availability of inputs (planting

Conference Paper

A Glimpse into the Biosynthesis of Terpenoids

Ingy I. Abdallah and Wim J. Quax

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Abstract

Terpenoids represent the largest class of natural products with a diverse array of structures and functions. Many terpenoids have reported therapeutic properties such as antimicrobial, anti-inflammatory, immunomodulatory and chemotherapeutic properties making them of great interest in the medical field. Also, they are widely used in the flavors and fragrances industries, in addition to being a source of biofuels. Terpenoids suffer from low natural yields and complicated chemical synthesis, hence the need for a more sustainable production method. Metabolic engineering provide an excellent opportunity to construct microbial cell factories producing the desired terpenoids. The biosynthetic mevalonate and non-mevalonate pathways involved in the production of terpenoid precursors are fully characterized so exploring methods to improve their flux would be the first step in creating a successful cell factory. The complexity and diversity of terpenoid structures depends mainly on the action of the terpene synthases responsible for their synthesis. These enzymes are classified into different classes and gaining insight into their catalytic mechanism will be useful in designing approaches to improve terpenoid production. This review focuses on the biosynthesis and biodiversity of terpenoids, understanding the terpene synthase enzyme family involved in their synthesis and the engineering efforts to create microbial cell factories for terpenoid production.

Keywords: amorphadiene; artemisinin; *Bacillus subtilis*; *Escherichia coli*; mevalonate; MEP; terpenoids; terpene synthases; taxol; taxadiene.

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1. Introduction

Nature is a treasure chest of an infinite number of commercially and/or medicinally significant compounds. Historically, most of new medicines have been derived from natural products (secondary metabolites) where chemical compounds from animals, plants and microbes have been invaluable in treating different human diseases ever since the dawn of medicine. Natural products have the inherent properties of high structural diversity and biochemical specificity making them leading scaffolds for drug discovery in addition to their use in food and fragrance industries [1–4]. It has been reported that 34 % out of new small-molecule medicines approved by the Food and Drug Administration (FDA) in the period of 1981 to 2010 were actually natural products

Conference Paper

Comparison of the Main Bioactive Compounds and Antioxidant Activity from Garlic Water-soluble and Garlic Oil

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Abstract

Garlic is a natural source which has abundant organosulfur constituents. Garlic is divided into water-soluble organosulfur constituents mainly SAC (S-allylcystein), NAC (N-acetylcysteine) and oil soluble organosulfur constituents such as DATS (diallyl trisulfide), DADS (diallyl disulfide), DAS (diallyl sulfide). The aim of this research was to compare the bioactive constituents and antioxidant activity between garlic water-soluble and garlic oil. Garlic water-soluble constituents were identified by Liquid Chromatography–Mass Spectrometry (LC-MS) and five constituents were found, namely N-acetylcysteine (NAC), cysteinyl-alanine, phenol-2-2-benzoxazolyl and two unknown constituents. The GC-MS chromatogram also showed three main constituents present in garlic oil as diallyldisulphide (DADS), diallyltrisulphide (DATS) and D-limonene. Interestingly, garlic water-soluble extract had higher antioxidant activity 70 % ± 0.02 % in comparison with garlic oil 58 % ± 0.07 %. This study conducts a novel preparation of garlic water-soluble for enhancing antioxidant properties on garlic novel preparation.

Keywords: antioxidant activity; garlic oil; garlic water-soluble; organosulfur constituents.

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1. Introduction

Humans are often exposed to stressful environmental factors such as radiations, chemicals, and stress resulting free radicals in cells. The abundance of free radical in cells leads to disrupted normal cellular metabolism [1]. Numerous studies revealed that antioxidants can eliminate harmful free radicals converting to neutral [2–6].

Garlic is regarded as the most common medical agent containing antioxidant activity [3, 5, 7]. Garlic acts as an exogenous antioxidant for neutralizing free radicals and helps prevent some diseases. It is a natural source which has abundant organosulfur constituents. Organosulfur has beneficial health effects particularly, inhibiting Reactive Oxygen Species (ROS) leading to oxidative stress [8].

Conference Paper

Transcription Pattern of Catalase Gene from *Gynostemma pentaphyllum* (Thunb.) Makino during Various Abiotic Stresses

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Abstract

Catalase (CAT) is a group of enzymes that protect cells against oxidative damage generated by reactive oxygen species. A CAT cDNA was previously isolated and characterized from 3-month-old hydroponically cultured *Gynostemma pentaphyllum* (Thunb.) Makino plants. The ORF is 1 479 bp with a deduced amino acid sequence of 492 residues. CAT from *G. pentaphyllum* has a molecular mass of 56.97 kDa with an isoelectric point (pI) of 6.95. The temporal expression analysis of leaf samples demonstrated that *GpCAT* expression could be up-regulated by various environmental stresses such as jasmonic acid electro, oxidative, salt, heavy metal, chilling and heat stress in a certain time period. A three-dimensional structural model of *G. pentaphyllum* based on its *GpCAT* cDNA sequence. The temporal expression pattern suggests that the *GpCAT* could play a role in the molecular defense response of *G. pentaphyllum* to abiotic stresses.

Keywords: Abiotic stress; Catalase; Gene expression; *Gynostemma pentaphyllum* (Thunb.) Makino.

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1. Introduction

Reactive oxygen species (ROS) are free radical substances that contain one or more unpaired electrons, which include hydrogen peroxide (H_2O_2), superoxide radical (O_2^-), hydroxyl radical (OH^-), etc. [1]. Plants contain several types of antioxidant enzymes that are able to control ROS concentrations during fluctuating environmental conditions. A complex antioxidant defense system has been developed with several antioxidant enzymes such as ascorbate peroxidase (APX), catalase (CAT), superoxide dismutase (SOD), glutathione reductase (GR), peroxidase (POD) and glutathione-S-transferase (GST) [2]. CAT (oxidoreductase, EC 1.11.1.6) is a tetrameric heme-containing intracellular enzyme which can rapidly degrade two molecules of H_2O_2 to water and molecular oxygen [3]. CAT, the first antioxidant enzyme to be discovered and characterized in plants, is found in almost all aerobic organisms and serves to break down hydrogen peroxide rapidly [2]. In contrast to animals, CAT in plants was encoded by a