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RESEARCH ARTICLE

Effectiveness of Lactic Fermentation and Convective Dehydration to Antioxidant Characteristics of Plumeria Flower Tea

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Abstract

Fermentation is believed as one of the oldest and most useful approach to maintain or improve phytochemical values. Convective drying is an economical and versatile dehydration method commonly applied in food and herb production. Plumeria flower contains a large number of phytochemical constituents and pharmacological activities. The benefits of plumeria flowers can be enhanced remarkably by processing it into a probiotic tea through lactic fermentation and convective dehydration. Lactic acid bacteria are able to accelerate the production of polyphenolic compounds as well as to improve antioxidant capability in this valuable herbal tea. This study penetrated on the utilization of lactic fermentation by *Lactobacillus acidophilus* culture in different innoculation ratio (0.05%, 0.1%, 0.15%, 0.20%, 0.25%) at the loading cell 10^9 cfu/g on plumeria flower during 37°C in 24 hours. Relying on bioconversion mechanism, we can obtain higher amount of active ingredients in the fermented tea. This study also emphasized on the convective drying temperature (45°C, 50°C, 55°C, 60°C, 65°C) in maintaining the active components inside plumeria flower tea during dehydration to safe mode (6.5% moisture). We noticed that the *Lactobacillus acidophilus* culture innoculation 0.20% (10^9cfu/g) and convective drying temperature 55°C were appropriate for plumeria flower tea production. From this production, consumers have better chance to use one kind of novel herbal tea from plumeria flower.

Keywords: *Plumeria flower, Lactobacillus acidophilus, Lactic fermentation, Convective dehydration, herbal tea.*

Introduction

Plumeria trees are popularly cultivated and distributed around the word. Plumeria white flowers with five petals are bisexual, fragrant, the upper portion whitish with small brilliant yellow centre [1].Their flowers mainly contain 1-diethoxyethane, citral, methylbenzoate, nerolidols, linalool, banzylbenzoate and methyl salicylate [2].The essential oils from the flowers are used for perfumery and aromatherapy purposes being possessed good fragrance [3].

People tend to prefer to safe products benefical for health. Herbal tea is rich in antioxidant components especially epigallocatechin gallate and epigallocatechin with multiple functional attributes such as anti-oxidant, anti-obesity anti-carcinogenic, neuroprotective, and cardio-protective [4, 5]. Functional compositions in herbal tea would be easily absorbed in human body in forms of simple or digest able molecules contributing to health benefits. Through bioconversion mediated by microorganisms, complex elements would be broken down into smaller ones by enzymatic reactions to facilitate their utilization [6, 8].Lactic fermentation is the most useful and common method to preserve food nutritive values. Main species of lactic acid bacteria belong to the genera *Lactobacillus, Pediococcus, Streptococcus* and *Enterococcus*. *Lactobacillus* spp. was found as dominant flora of the fermented herbs [9].

Herbal fermentation by lactic acid bacteria has been demonstrated to increase the antioxidant capacity on herbal tea [10]. Apart from proliferation inhibition of undesirable or pathogenic bacteria by lactic bacteria, cell wall decomposing enzymes of the lactic acid forming bacteria contribute to the maceration of the herb substract, while improving the bioavailability of the herb secondary metabolites [11]. During fermentation, carbohydrates and related constituents are partially oxidized and energy is released in the absence of any external electron acceptor [12].

Fermentation enables to increase total phenolic compound content due to the bio-conversion of phenolic compounds from their conjugated forms to their free form [13]. Several notable reports mentioned to the lactic fermentation on herbs. One study evaluated and compared the antioxidant capacity between freshly prepared and lactic fermented herbal teas [14].

One research investigated a novel anti-obesity fermentation product by combining H. cordata leaf tea with green tea, using Lactobacillus paracasei subsp. Paracasei for bioconverting the polyphenolic compounds during lactic fermentation [5]. Convective drying is applied to remove moisture from the food matrix through the application of heat in evaporation [15]. Hot air is passed through the product to transfer the heat to the food and water is removed [16].

Convective dehydration can affect different heat sensitive components by causing nutritional, physical, chemical and sensory changes. Heat-sensitive compounds were heavily damaged due to high energy content [17]. Pupose of our study focused on the effectiveness of lactic fermentation and convective dehydration to antioxidant characteristics of plumeria flower tea

Material and Method

Material

Plumeria flowers were obtained from orchards in Can Tho city, Vietnam. After collecting, they must be quickly conveyed to laboratory for lactic fermentation and convective drying. *Lactobacillus acidophilus* culture was supplied from Pasteur institute. Chemical substances and reagents such as Folin-Ciocalteu reageant, Na_2CO_3, Gallic acid, $NaNO_2$, $AlCl_3 \cdot 6H_2O$, NaoH, catechin, ethanol, methanol, potassium per sulfate, phosphate buffer, potassium hexacyanoferrate, trichloroacetic acid solution, ferric chloride, ascorbic acid, ferrous sulfate, FRAP reagent, acetate buffer were all analytical grade supplied from Rainbow Trading Co. Ltd., Vietnam.

Researching Procedure

Plumeria flowers were steamed for 2 minutes before experiments. These steam flowers were subjected to fermentation process by *Lactobacillus acidophilus* with inoculation ratio culture (0.05%, 0.1%, 0.15%, 0.20%, 0. 25 %) containing load at 10^9 cfu/g in 24 hours at 37°C. These fermented samples would be dried at different convective drying temperature (45°C, 50°C, 55°C, 60°C, 65°C) to the final moisture content 6.5%. All treated samples were then stored in dry cool place before evaluating total phenolic (mg GAE/100g), total flavonoid (mg GE/100g), DPPH (%) and FRAP (mmol Fe^{2+}/g).

Antioxidant Capacity and Statistical Analysis

Total phenolic (mg GAE/ 100g) was estimated spectrophotometrically using Folin-Ciocalteu reagent [18]. Total flavonoid (mg GE/ 100g) was estimated spectrophotometrically [19]. DPPH (%) radical-scavenging activity was determined using reducing power assays [20].

The FRAP (mmol Fe^{2+}/g) was determined as described by Chung H et al [21]. The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Stat graphics Centurion XVI.

Result & Discussion

Effect of Lactic Fermentation to Antioxidant Capacity of Plumeria Flower

Plumeria flower oil mainly consists of primary alcohol, such as geraniol, citronellol, farnesol and phenyl ethyl alcohol and some linalool [22]. Plumeria flower undergoing microbial fermentation represented a unique phytochemical profile than unfermented one (see table 1). After 24 hours of lactic fermentation at 37°C by *Lactobacillus acidophilus* (10^9 cfu/ml), a positive effect on the total phenolic, total flavonoid, DPPH and FRAP was clearly noted at ratio 0.2%. Our results were similar to other findings [23, 29].

It's possibly due to the enzymatic reaction on the substrates that released various bioactive components as the final fermented product [30, 31]. The hydrolytic activity of enzymes produced by fermenting microorganisms promotes the structural breakdown of cell walls thus resulting in a greater bio-accessibility and bio-availability of bound and conjugated phenolic compounds [32]. Lactic fermented herbal teas exhibited higher phenolic contents, flavonoid contents and antioxidant properties compared to the freshly-prepared ones [14].

Table 1: Effect of lactic fermentation to antioxidant capacity of Plumeria flower

Parameter		*Lactobacillus acidophilus* ratio (%) at loading cells (10^9 cfu/ml)				
	Control	**0.05**	**0.1**	**0.15**	**0.2**	**0.25**
Total phenolic (mg GAE/ 100g)	21.43±0.02^e	28.75±0.02^d	31.42±0.01^c	34.57±0.02^b	37.80±0.03^b	37.87±0.01^a
Total flavonoid (mg GE/100g)	6.19±0.01^d	8.45±0.00^c	9.24±0.00^{bc}	10.17±0.02^b	12.71±0.02^a	12.80±0.02^a
DPPH (%)	31.13±0.00^3	48.79±0.01^d	52.38±0.03^c	55.53±0.01^b	57.83±0.00^a	57.91±0.00^a
FRAP (mmol Fe^{2+}/g)	0.22±0.03^c	0.28±0.02^b	0.31±0.01^{ab}	0.34±0.03^{ab}	0.37±0.00^a	0.37±0.03^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Effect of Drying to Antioxidant Stability in Plumeria Flower Tea

Convective dehydration was the most popularly applied drying method to eliminate water from herbs. Temperature in dehydration was a critical factor for the postharvest management and the merchantability of herbs. The low drying temperature prevented against the decomposition of phytochemical components, however it is slow and metabolic process may continue longer [33]. In our research, the plumeria flower after being fermented by lactic bacteria would be dried under different drying temperatature (45^{o}C, 50^{o}C, 55^{o}C, 60^{o}C, 65^{o}C) to the final moisture content 6.5%. Our findings revealed that the most antioxidant characteristics still maintained at utmost level by convective drying at below 55^{o}C (see table 2). In another report, a suitable convective drying method to dehydrate *C. alata* leaves was at 40 °C [34].

Table 2: Effect of drying to antioxidant stability in Plumeria flower tea

Parameter	Convective drying temperature (^{o}C)				
	45	**50**	**55**	**60**	**65**
Total phenolic (mg GAE/ 100g)	35.41±0.03^b	35.63±0.00^{ab}	35.94±0.02^a	34.02±0.01^c	33.49±0.01^d
Total flavonoid (mg GE/100g)	12.04±0.02^b	12.16±0.01^{ab}	12.34±0.03^a	11.84±0.03^{bc}	11.70±0.00^c
DPPH (%)	56.31±0.00^b	56.73±0.00^{ab}	56.94±0.01^a	54.75±0.01^c	53.18±0.01^d
FRAP (mmol Fe^{2+}/g)	0.32±0.00^b	0.35±0.03^{ab}	0.36±0.00^a	0.30±0.00^{bc}	0.27±0.03^c

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

Conclusion

Plumeria flower herbal tea is rich in antioxidant capacity in nature. These functional values woud be enhanced via lactic fermentation. Supplementation of Lactobacillus acidophilus culture into plumeria flower during lactic fermentation results in the breakdown of the complex components, accelerating the feasibility of the phytochemical utilization, speeding up their bioavailability, releasing innovative active compounds through microbial metabolism. Optimal dehydration temperature is also very important to preserve the most valuable antioxidant contents. We have strongly realized that lactic fermentation and convective drying temperature greatly affected to antioxidant capacity and stability of plumeria flower tea.

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