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Development of *Dendrobium officinale* pulpy drink

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Abstract— *D. officinale is a renowned botanical species in China with a rich historical background associated with its extensive use in traditional medicine. This research aims to develop a pulpy drink using the Stem of the D. officinale plant and enhance its thermal stability. In order to enhance the thermal stability of the beverage, multiple amounts of xanthan gum were used in the formulation. The physical stability of the D. officinale pulpy drink was assessed by measuring particle size, Zeta potential, particle sedimentation, viscosity, and color. The current research findings indicated that the beverage with a composition of 3% D. officinale pulp and 0.4% xanthan gum exhibited the highest level of physical stability. This beverage exhibited the smallest particle size, negative zeta potential, viscosity, and no sedimentation.*

Keywords— ***Xanthine gum, D. officinale, herbal drink, Drink development, Drink stability.***

I. INTRODUCTION

Dendrobium is enriched in carbohydrates, which is used as oral medicine. It is also a main component of various food items and drinks [1]. In China, this is used as medicine for increasing the secretion of saliva and helping moisten the lungs. This polysaccharide is very prominent in medicine; various genera of *D. officinale* are used [2]. These plants from *the Orchidaceae* family are generally believed to help improve eyesight, relieve fever, and protect from CVDs if we use them as eatable or drink them. This is why people of China consider this plant one of the best herbs to cure all diseases and use it to increase their lifespan [3]. Various species present in the world of this plant include *D. aphyllum, D. candidum, D. chrysanthum, D. densiflorum, D. crystallinum, D. fimbriatum, etc.* [4].

Making drinks from plant extract as medicine is the traditional way to treat diseases in China. In the case of immunity, there is a drink known as National Herbal Drink (NHD). This drink has ingredients like *D. officinale, Atractylodes macrocephala Koidz., Paeonia lactiflora Pall., Lycium barbarum L., and Glycyrrhiza uralensis Fisch.* This drink is mostly consumed by individuals who have low immunity levels. In this drink, the prominent constituent is *D. officinale*, which plays an important role as an antioxidant, lowers blood pressure, and helps to fight liver diseases. Many studies have demonstrated that this compound also improves the mechanisms of phagocytosis by activating the macrophages; hence, their function is improved. In the gut of mice, there is a diversity of various microbes or microbiota. Their variety is also increased due to this compound [5].

The structure of *D. officinale* consists of various polysaccharide sub-units that may include glucose, pyranose, *etc*. The beta-glycosidic bond is present in the sugar sub-units of this compound. It has also been evaluated that the intestine and stomach secretions cannot digest this compound. This compound is converted through digestion in various products like lactic acid, propanoic acid, lactic acid, etc. [1]. The *D. officinale* flower is also a food additive, sweetener, and drink. Its scent makes an individual stress-free. However, to give more color taste and improve the shelf-life of the drink, various additives like honey and alcohol are also used. These can then be used for therapeutic applications [6]. Due to the higher molecular weight and viscosity of *D. officinale,* it is used in the food industry to give the food gelling property [7]. Many Asians believe that *D. officinale*, when used as soup or juice, is more effective and used as a functional food [8]. *D. officinale* flower is also used as raw material in soft candy preparation. This soft candy is like gellies. In the Republic of China, another variety of Dendrobium is used in the food items and barrages known as *D. nobile LindI*. This plant consists of alkaloid compounds that protect the body from dementia abnormalities in the natural cell death process and protect it from neural diseases [9].

II. MATERIAL AND METHODS

2.1 Sample preparation

In this step, the plant stems were selected based on certain criteria such as ripeness, no signs of deterioration, and no foreign ingredients. Stems were washed twice to decontaminate. After washing, the Stem was weighed with analytical balance (Shanghai Yousheng Co., Ltd., Shanghai, China) and blended with water in a high-speed blender of 0.3:10 (w/v) provided by Shenzhen Kangjia Electronics, Shenzhen, China. This blended mixture was ground for 20 min using a collide mill to make a fine pulp. After that, hydrocolloids were added to the drink and mixed using a high-speed mixer (Shanghai Lichen Bangxi Instrument Technology Co. Ltd., Shanghai, China) at 1100 rpm for 10 min. Finally, the *D. officinale* drink was sterilized in an autoclave at 121 ℃. Different ratios of xanthan gum were used to investigate the physical stability of the drink. Formulations with xanthan gum were applied as follows: T1 0.1%, T2 0.2%, T3 0.3% and T4 0.4%. *D. officinale* pulpy drink was transferred to 50 ml glass bottles and sterilized in an autoclave (Bosun Medical Biological instrument, Shanghai, China). After sterilization, they were kept at room temperature to cool down and used for further analysis.

2.2 Particle Size Analysis

The particle size measurement was conducted using a methodology previously outlined by Ni et al. [10]. In this study, the *D. officinale* beverage samples' particle size was assessed using a laser diffraction technique, employing a Laser particle size analyzer (S3500, Microtrac Corporation of America). The sample was diluted 10 times with deionized water, and 5 ml was injected into the machine.

2.3 Zeta potential

The Zeta potential is an important parameter that significantly impacts the stability of colloidal systems. It was measured with a methodology previously outlined by Ni et al. [10]. It was calculated by using a Nano-size and zeta potentiometer. The samples underwent a dilution process of 50-fold using deionized water. Subsequently, these diluted samples were utilized to assess the zeta potential under ambient conditions. The final measurements of zeta potential values were obtained by doing a triplicate analysis of the beverage samples.

2.4 Particle Sedimentation

Natural sedimentation of *D. officinale* drink was measured by the volumetric method. In this method, the *D. officinale* pulpy drink was put in measuring cylinders and afterward kept at a temperature of 4 °C for 24 hours. The volumetric determination of separation was conducted in percentage after the storage process.

2.5 Drink Viscosity

A touchscreen digital viscometer was used to determine the viscosity of the *D. officinale* pulpy drink. A 15 ml sample was measured with spindle number 1 at 1.24/s share rate for 2 min.

2.6 Drink Color Analysis

In order to analyze the color properties and variations, a precision spectrophotometer (Ultra scan Pro, Hunter lab) was used. The values were measured in L, a*, and b*, where L, a*, and b* are referred to as brightness, green/red, and blue/ yellow, respectively. The spectrophotometer was calibrated as per company guidelines. After that, the sample was inserted into the apparatus, and color readings were evaluated.

2.7 Statistical Analysis

All the data is arranged and calculated by MS Excel 2019, Minitab, and Origin. ANOVA is one-way with LSD, used to calculate the statistical data. Data is presented in charts with standard deviation (±SD) and significant value $p > 0.05$.

III. RESULTS AND DISCUSSION

2.8 Size of particles in pulpy drink

The use of a high-speed blender and a colloidal mill reduced particle size. The sample was collected at different stages to determine the particle size of blended and ground drinks. Blending for 7.5 minutes reduced the particle size to 127 micrometers, and grinding for 20 minutes reduced it to 45 micrometers at optimal levels (Fig. 1A). The thermal treatment of beverages resulted in a significant rise in particle size (Fig.1 B). After the sterilization process, the control sample showed a significant rise in particle size (100 um). A variation of 55 micrometers indicated the presence of large aggregated particles. The particle size difference was decreased to the initial particle size of the pulpy drink (45 micrometers) by increasing the ratio of xanthan gum.

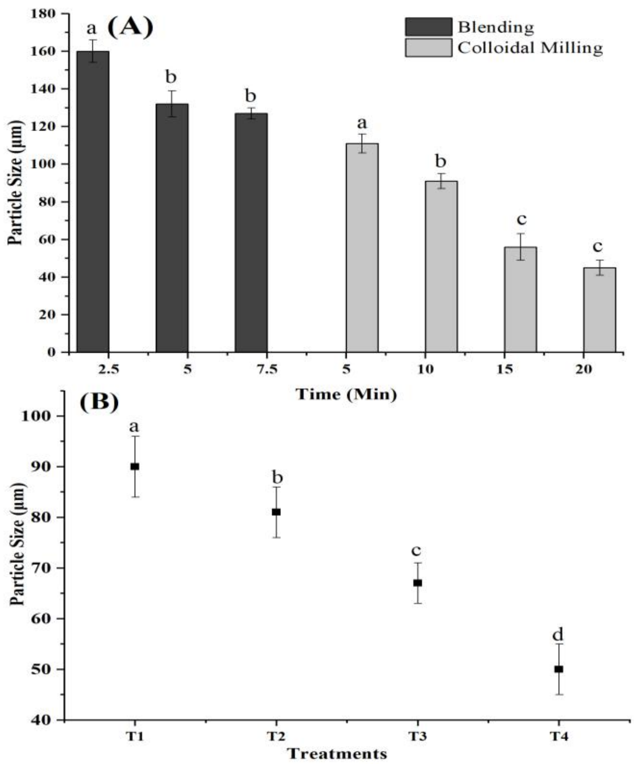

Fig.1: Particle size reduction in response to increasing the time of blender and collide mill (A) and Particle size of the formulations in response to Autoclave sterilization (B). Error bars present ±SD, and small letters present significant differences.

The observed increase in particle size could be because of the coagulation and denaturation of proteins and the aggregation of carbohydrates caused by the elevated temperature during sterilizing. The results of this research align with the conclusions drawn in a prior study conducted by Ni *et al*. [10]. According to a study conducted by Liu, Sun, Xue, and Gao *et al*. [11], the process of sterilization, specifically at a temperature of 121 ◦C for over 25 minutes, resulted in decreased physical stability in walnut beverage emulsions because of the denaturation and coagulation of walnut protein. While the observed increase in particle size of T4 was within the acceptable limit in this study, the drink remained stable. However, adding xanthan gum in combination with *D. officinale* polysaccharide showed advantageous effects in reducing the aggregation of suspended particles and enhancing the stability of the drink.

2.9 Zeta Potential of pulpy drink

The zeta potential values observed for all samples had a significant negative polarity, suggesting an abundance of negatively charged particles relative to positively charged particles in the turbid drink. This could be attributed to two factors: the isoelectric point (pI) of the *D. officinale* polysaccharide and the characteristics of the introduced stabilizers. The polysaccharide derived from *D. officinale* has a net negative charge, primarily due to the presence of uronic acid [12]. It was observed in this study that the value of the zeta potential in the beverage samples, which were supplemented with xanthan gum and subjected to the autoclave sterilization method, exhibited significantly negatively higher zeta values (Fig. 2). However, the anionic characteristics of xanthan gum and *D. officinale* polysaccharide resulted in the presence of negatively charged particles. After sterilization, it was observed that the zeta potential values of all drinks exhibited a rise. It may be attributed to a probable decrease in the effective surface charge of dispersed particles, which the aggregation of these particles may have generated. Their effective surface charge influenced suspended particles' dispersion and aggregation [13]. It suggests that the dispersed particles present in the drink exhibited limited aggregation tendencies as a result of the significant electrostatic repulsion forces.

*2.10*Particle Sedimentation in a pulpy drink.

Xanthan gum possesses several hydroxyl groups that actively bind to water molecules, facilitating the development of gel and viscous solutions [14]. Being an extracellular heteropolysaccharide, Xanthan gum is widely utilized as a thickening agent and emulsifier to improve the stability of food products [15]. Xanthan gum was also found stable in high temperatures, making the *D. officinale* drink stable [16]. As shown in Fig. 3 (A), the control sample had 35% sedimentation, but adding 0.4% xanthan gum reduced it to 0% (Fig. 3E). It could be because of the characteristics mentioned above of xanthan gum that it bounded the water and made a viscous solution to hold up the suspended particles.

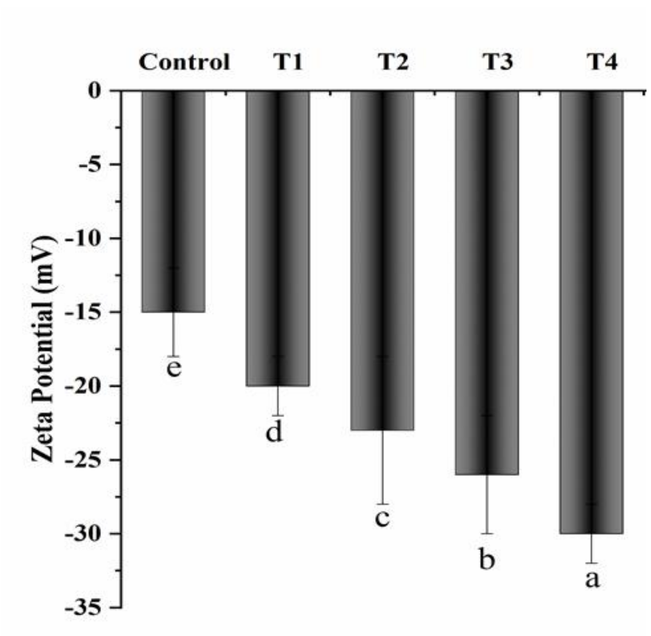

Fig.2: Zeta potential of the formulations. Error bars are presenting ±SD and small letters are presenting significant difference.

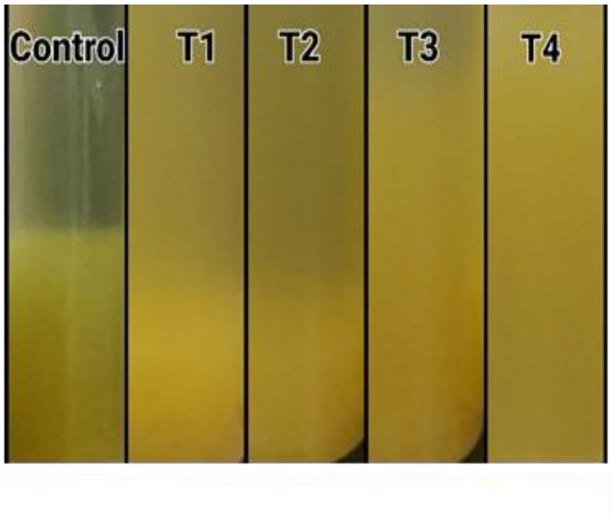

Fig.3: Particle sedimentation photograph of all the formulations

2.11 Viscosity of pulpy drink.

As presented in Table 1, the control sample indicated that the polysaccharide of *D. officinale* was not thermally stable [17]. However, after sterilization, the control sample significantly reduced the viscosity, and adding xanthan gum helped improve the viscosity of the drink to make it stable. The results suggested that xanthan gum improved efficiency in making a stable *D. officinale* pulpy drink by increasing the viscosity and protecting it from high heat impact. It has shown that incorporating hydrocolloids, typically at concentrations ranging from 0.1% to 3.0%, may effectively enhance the stability of cloudiness in drinks [16, 18]. Significant improvements may be attained with the incorporation of xanthan gum because of its exceptional capacity to exhibit higher viscosity at low shear rates. It can be attributed to the higher molecular weight and distinctive stiff rod-like structure of xanthan gum, which may also account for the pronounced shear thinning behavior seen in drinks thickened with the xanthan gum [19].

Table 1: Viscosity of the D. officinale pulpy drink with different xanthan gum ratios. Small letters in every column show a significant difference.

Formulations	Prior to sterilization	After sterilization
Control	$15.62 \pm 0.06_e$	$2.19 \pm 0.03_e$
T1	$29.12 \pm 0.03_d$	$12.35 \pm 0.05_d$
T2	$56.9 \pm 0.02_c$	$38.75 \pm 0.07_c$
T3	$86.43 \pm 0.05_b$	$62.15 \pm 0.08_b$
T4	$123.65 \pm 0.09_a$	$75.83 \pm 0.02_a$

2.12 Color Analysis of pulpy drinks

The acceptability of a food product may be greatly influenced by its color, with the proportional significance of this factor fluctuating across different food systems [20]. One of the drawbacks associated with thermal treatments is the alteration of pigments due to high heat, leading to modifications in the original hue of the food substance. Chlorophyll (the pigment responsible for the green color) degrades during high-heat processing, resulting in pheophytins (the pigment responsible for the gray-brown color), which is strongly correlated with a drop in product quality [21].

This study observed a significant alteration in the hue of all beverages compared to the control sample. All autoclaved sterilized drinks turned green to yellowish, as presented in Table 2. It could also be because of the degradation of chlorophyll under high heat. There was also a correlation between temperature and the polymerization reaction between pigments and polyphenols, which increased the possibility of degradation and destruction of pigments in drinks as the temperature increased [22].

Table 2: Color Analysis of sterilized D. officinale pulpy drink. Small letters in every column show a significant difference.

Formulation	L	a*	b*
Control	$44.65 \pm 0.3_c$	-1.56_c	67.01_a
T1	$58.72 \pm 0.1_b$	-0.17_b	43.36_b

T2	58.80 ± 0.1$_b$	-0.16$_b$	43.32$_b$
T3	60.64 ± 0.4$_a$	-.01$_a$	45.32$_c$
T4	60.61± 0.2$_a$	-.02$_a$	45.39$_c$

IV. CONCLUSION

The addition of hydrocolloids and their precise amounts has significantly influenced the physical stability of liquid beverages. Xanthan gum is an additive that enhances the stability of beverages due to its hydroxyl groups, which have the potential to bind water molecules and elevate the viscosity of the drink. This research indicates that enhancing the beverage's viscosity by optimizing the gum ratio and reducing the particle size might improve its stability. The physical stability of the Dendrobium officinal pulpy drink containing 0.4% Xanthan gum and 3% pulp was the highest after sterilization.

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