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The physicochemical quality of yellow chrysanthemum flower (*Chrysanthemum indicum*) brewed drink

Prabawa, S., Raida, A., Hartanto, R. and *Yudhistira, B.

Department of Food Science and Technology, Faculty of Agriculture, Sebelas Maret University, Jl. Ir. Sutami 36A, Surakarta, Indonesia

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Abstract

Chrysanthemum flowers (*Chrysanthemums indicum*) are processed into several products such as brewed drinks because they have good health benefits. The production process of commercial chrysanthemum flower brewed drinks still uses a conventional dryer with solar energy, this can reduce the quality of dried chrysanthemum flower both physical and chemical quality. Our objectives were to evaluate the chemical and physical quality of yellow chrysanthemum flower brewed drink by a cabinet dryer (CD). The materials used were fresh yellow chrysanthemum flowers with a moisture content of 83.00% (wb). The experimental design of this study used six treatments, including CD at 40°C, 50°C, 60°C, fresh flowers, and commercial chrysanthemum brewed drinks obtained from the market with storage of 1 day and 2 weeks. The parameters analyzed were moisture content, water activity, shrinkage, colour, antioxidant activity, total phenol, and sensory analysis. After evaluation demonstrated that the drying method using a CD at 60°C was the most optimal drying, with an average moisture content value of 15.18% (wb), the value of water activity is 0.25, shrinkage value for length and width, respectively 18.17% and 14.89%, the antioxidant activity of 87.67%, total phenol of 15.17%, and sensory evaluation results with the best formulation obtained in the sample with drying CD at 60°C.

1. Introduction

Chrysanthemum (*Chrysanthemums indicum*) is one type of local plant horticultural commodity which is commonly cultivated as an ornamental plant, as complementary decoration, or as a souvenir in a celebration. In China and Korea, yellow chrysanthemum flowers are well-known as small yellow flowers that can be eaten and are medicinal plants that have been used for traditional medicine (Kim *et al*., 2012). Chrysanthemum is kind of cut flower that experienced the largest increase in harvested area, by 6.61% from 1,091.42 hectares to 1,163.55 hectares and experienced the largest increase in production with a total of 47.58 million stalks (10.99%) in 2013 (BPS, 2017).

The central provinces in Indonesia for ornamental plants are Bali, Central Java, Banten, West Java, East Java, North Sumatra, and Bali. The highest chrysanthemum flower production data in 2017 was in West Java province with a total of 186.313,493 stalks and the second is Central Java province with a total of 144,999,627 stalks (BPS, 2017). This is one of the considerations for choosing chrysanthemum flowers as research raw materials considering that Central Java province is the second producer of chrysanthemum flowers in Indonesia, most of which are located in Bandungan, Magelang, and Tegal. The high public interest in this chrysanthemum flower is due to its beautiful shape and variety of colours, and not wilt quickly (Purwono *et al*., 2014). The many types, shapes, and colours of the chrysanthemum flower make this flower more widely used in Indonesia as an ornamental and floricultural plant (Teixeirada, 2003) and as a culinary plant packaged in the form of brewed drinks and snacks (Zulkarnain, 2009). Considering that Indonesia is a country that consumes flowers and spices as a traditional drink that is rich in health benefits (Yudhistira and Choiriyah, 2021; Setyowati *et al*., 2023). These are usually made based on ingredients found in Indonesia (Yudhistira, 2020), including chrysanthemums flower.

According to Sugiri (1998), yellow chrysanthemum flowers have the dominant pigment, namely carotenoids. Chrysanthemum flower brewed drink as a tea product with a distinctive aroma and taste contains beta-carotene, vitamins, and flavonoids (Puspita and Labola, 2018). Ravishankar *et al*. (2013), said that flavonoids and phenolics are considered important compounds in food

*Corresponding author.
Email: *barayudhistira@staff.uns.ac.id*

to reduce the risk of metabolic syndrome and diabetes-related complications. Phenolic acids have antioxidant, antimutagenic, antiphlogistic, antibacterial, and other properties (Hao *et al*., 2012). The main process of making chrysanthemum flower brewed drink is through the process of washing, withering, drying, and packaging. Chrysanthemum flowers are agricultural products that are perishable (Sulaimana *et al*., 2021); they need handling to extend their shelf life, including drying. In addition, the purpose of withering and drying in question is to reduce and eliminate the amount of moisture in the material. In the existing processing of chrysanthemum flower brewed drink, the drying process is usually carried out by sunlight (sun drying) or in an oven at 60°C for 24 hrs. This allows damage to both the physical and chemical characteristics of the chrysanthemum flower. Muchtadi and Sugiyono (2013) explained that each food commodity will have different temperatures and drying efficiency, depending on the type of material and drying method. Herbal types such as chrysanthemum flowers can be dried in a temperature range of 30-90°C, but the best temperature is not to exceed 60°C (Kencana, 2015). According to previous studies on the drying of flower commodities, experiments were carried out at a temperature of 40-60° C to achieve a moisture content of less than 10% (Aryani, 2002). Therefore, this study was conducted to determine the drying rate of yellow chrysanthemum flowers as the material for making chrysanthemum flower brewed drink using a CD, hence the best temperature and drying time can be obtained to obtain good quality standards of dry chrysanthemum flower and can maintain physical, chemical, and sensory characteristics.

2. Materials and methods

2.1 Materials

Whole yellow chrysanthemum flowers and dried chrysanthemum flowers were obtained from Bandungan District, Semarang Regency and Hargobinangun Village, Pakem, Sleman, Yogyakarta.

2.2 Chrysanthemum brewed drink making

The process of making chrysanthemum brewed drink goes through the sorting stage or selection of raw materials, weighing, washing and draining to remove some dirt, withering to inactivate the polyphenol oxidase enzyme carried out for 24 hrs at room temperature (28-30°C), and drying at 40°C, 50°C, and 60°C by CD method.

2.3 Analysis of water content

Determination of the water content analysis in the material was carried out based on the oven method (AOAC, 2012). Sample (2 g) was heated at 105°C by oven for at least 3 hrs or more and then cooled in a desiccator for 30 mins. This treatment was carried out several times until the sample weight obtained was constant until the difference in numbers is less than 0.01. Calculation of water content can be obtained through the following formula (Sudarmadji and Bambang, 2003):

$$Moisture\ content\ (wet\ basis) = \frac{(W1-W2)}{(W1-W3)} \times 100\% \quad (1)$$

$$Moisture\ content\ (dry\ basis) = \frac{(W1-W2)}{(W2-W3)} \times 100\% \quad (2)$$

Where W_1 is sample weight and the cup before heating, W_2 is sample weight and the cup after being heated, and W_3 is the weight of the empty cup.

2.4 Drying rate analysis

According to Hossain and Bala (2002) the drying rate can be determined based on the calculation of the difference of moisture content of the material during drying on a dry basis, against the time used during drying. The drying rate formulae (Akpinar and Toraman,2016) (Equation 3):

$$\frac{DR}{dt} = \frac{M_t - M_{t+dt}}{t} \quad (3)$$

Where, DR/dt is drying rate in units of $\frac{kg_{water}}{kg_{dry\ materials}}.h$, M_t is moisture content (dry basis) at t, M_t+dt is moisture content (dry basis) at t+ dt, and t is the drying time (h).

2.5 Moisture ratio analysis

Determination of the moisture content ratio (MR) during drying used equation (Doymaz and Pala, 2003):

$$MR = \frac{M-Me}{Mo-Me} \quad (4)$$

Where, M is the moisture content (dry basis) at t, M_e is the equilibrium moisture content, and M_o is the initial moisture content (dry basis). The equilibrium moisture content (M_e) was determined using the following equation based on Brooker *et al*. (1982) (Equation 5):

$$1 - RH = \exp\left(-c\,T\,Me^{n}\right) \quad (5)$$

Where, the values of the constants c and n are 0.0173 and 1.0423 (Henderson model), respectively, and T is the drying temperature, therefore the equation for the equilibrium moisture content formula with the Henderson model can be written:

$$1 - RH = exp\left(-0.0173\,T\,Me^{1.0423}\right) \quad (6)$$

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2.6 Water activity analysis

Water activity (a_w) can be calculated using the ratio between the water vapor pressure of the material (P) and the vapor pressure of pure water (Po) at a balanced temperature condition, hence it can be formulated into the following equation (Adnan, 1980):

$$a_w = \frac{P}{Po} = \frac{ERH}{100} \quad (7)$$

ERH is the balanced relative humidity.

2.7 Shrinkage of chrysanthemum flower analysis

The shrinkage of the dimensions of the material can be calculated using the following formula (Imaniar, 2020):

$$Long\ shrinkage = \frac{Po - Pa}{Po} \times 100\% \quad (8)$$

Where Po is the initial length before drying, and Pa is the length after the sample is dried.

$$Wide\ shrinkage = \frac{lo - la}{lo} \times 100\% \quad (9)$$

Where lo is the initial width before drying, and la is the sample width after drying.

2.8 Antioxidant activity analysis

The DPPH method was used to determine antioxidant activity, the procedure carried out was by making each sample at a certain concentration in methanol solvent. Then each sample was pipetted and put into a vial to add DPPH solution. The mixture was homogenized and left for 30 mins and measured with a UV-Vis spectrophotometer at 517 nm. The antioxidants activity is calculated using the following formula (Syafrida *et al*., 2018):

$$\%\ antioxidant\ activity = \frac{blank\ absorbance - Sample\ absorbance}{blank\ absorbance} \times 100\% \quad (10)$$

2.9 Total phenol analysis

Total phenolic test of dry chrysanthemum flower samples was tested using the Folin-Ciocalteau method. Determination of the total phenol content was done by making a sample extract first and then adding distilled water and Folin-Ciocalteau reagent at a certain concentration. Then the sample was homogenized and allowed to stand for 8 mins and given 10% of Na_2CO_3. The mixture was allowed to stand for up to 1 hr at room temperature, then the absorption was measured using a UV-Vis spectrophotometer at its maximum wavelength (Khadijah *et al*., 2017).

2.10 Colour analysis

Testing the physical characteristics of dried chrysanthemum flowers was done by analyzing the colour. This test used the hunterlab colourFlex spectrophotometer. The colour test with the Hunter L* (white), a* (red), b* (yellow) colour system was carried out by first calibrating the chromameter with the white colour standard on the tool, the resulting white degree analysis was the value of L*, a*, b* and ΔE. The measurement of the total degree of colour used a white base as the standard (Kaemba *et al*., 2017).

$$\Delta E = \sqrt[8]{L^2 + a^2 + b^2} \quad (11)$$

2.11 Sensory evaluation

The organoleptic test used hedonic test method where the panellists will be provided a subjective assessment based on their respective level of preference for the sample presented (Permadi *et al*., 2018). The assessment of this test includes several parameters such as aroma, colour, taste, aftertaste, and overall. For sensory scale consist of 1 = really don't like it 2 = don't like it, 3 = neutral, 4 = like, 5 = really like

2.12 Statistical analysis

A completely randomized design (CRD) was used with one factor, namely temperatures of 40°C, 50°C, and 60°C to evaluate the appropriate drying rate to reduce the moisture content of the material to less than 8% (BSN, 2013). One-way Analysis of Variance (ANOVA) using SPSS version 20 used to test the data and Duncan's Multiple Range Test (DMRT) at the significance level of α = 0.05.

3. Results and discussion

3.1 Water content

The difference in water content in each sample, fresh chrysanthemum flower has the highest water content (wb and db) show in Table 1. While the samples were dried using a CD at 40°C, 50°C, and 60°C, the highest moisture content was obtained by drying at 40°C. Results of the CD have met the quality requirements of "Packaged Dried Tea in National Standard of Indonesia (SNI 01-3836-2000)", which is not more than 8%. The use of a CD does not have a significant difference in water content, although the temperature has been increased from 40°C to 60°C. This case occurs possibly because the evaporation of water is less than optimal during the drying process, periodic weighing of the material allows the entry of moisture into the matrix and causes the material moisture content to become less stable, besides this phenomenon can be caused by a reduction in the size of the material that is not optimal before drying (Lisa *et al*., 2015). The drying process that is not optimal can be caused by the dryer leaks when used for a long time and the process of opening the lid at

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the time of weighing which causes changes in conditions in the drying room. Additionally, when using the foam mat drying technique, trapped gas bubbles in the foamy layer can speed up water evaporation to create low density dry powder (Yudhistira *et al*., 2020).

Table 1. Moisture content of chrysanthemum flower.

Treatment	Moisture Content (%)	
	Wet basis (wb)	a_w
Fresh flower	83.00±0.03[d]	
CD 40	15.70±0.10[b]	0.32±0.01[a]
CD 50	13.42±0.02[a]	0.33±0.01[a]
CD 60	15.18±0.01[b]	0.20±0.01[b]
Commercial 1 day	17.08±0.02[c]	
Commercial 2 weeks	16.85±0.03[c]	

Values are presented as mean±SD of triplicates, n = 3. Values with different superscripts within the same column are statistically significantly different (p<0.05). CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

3.2 Water activity

Chrysanthemum flowers water activity by drying using a temperature of 40°C, 50°C, and 60°C are 0.32; 0.33; 0.20, respectively (Table 1). The previous study by Bimantara (2015) found the higher temperature and duration of heating, the water activity would be lower value. This is caused by the high heating temperature that can reduce water activity to a low level. The water activity at 60°C has the lowest water activity. The importance of measuring the value of water activity in foodstuffs is because the water content can affect the growth of microbes in the material. According to Suhardi (2007), the disease that often attacks chrysanthemum flowers is rust and the cause is *Puccinia* sp. One of the efforts to strengthen the resistance of plants and prevent the growth of microorganisms is by drying, in order to reduce or eliminate some of the water (Belitz *et al*., 2009). The higher the water content shows the higher the aw value. The minimum aw to microorganisms grow such as bacteria at 0.90; yeast at 0.8 – 0.9; mold at 0.6 – 0.7. Drying is used for removing water and extend shelf life of product (Belitz, 2009).

3.3 Drying parameter

Parameters for drying chrysanthemum flowers can be seen in Figures 1-3. The drying rate of yellow chrysanthemum flowers which were dried in a CD at 40° C (Figure 1), the constant drying rate was not obtained, this tends to be the same as the research on drying rosella flowers (Nugroho and Suherman, 2012) which showed that the dried flower petals belonged to the type agricultural crops, which generally drying of agricultural crops do not obtain a constant drying rate (Krokida *et al*., 2003). While the drying rate of yellow chrysanthemum flowers at 50°C showed a constant drying rate, namely at 0 to 2.5 h, with the calculation results of drying rates from 5,500 to 3,133 kg water/kg of material. Furthermore, from the 3rd to the 22nd hour, the drying rate decreases. This is in line with Desrorier (1988), the more water will evaporate from the material in higher the drying temperature. Drying time is also getting shorter along with the increase in the given temperature, and water transfer will be faster also (Riansyah *et al*., 2013). In addition, the results obtained at a drying rate of 60°C require a fairly short time therefore drying takes place more quickly. This causes CD at 60°C to have a higher drying speed than CD at 40°C and 50°C. The relationship between temperature and time of drying process is directly proportional. In accordance with the theory which states that the higher the temperature, the greater the heat energy carried by air. This causes an increasing number of liquid masses evaporation from material (Taib *et al*., 1988).

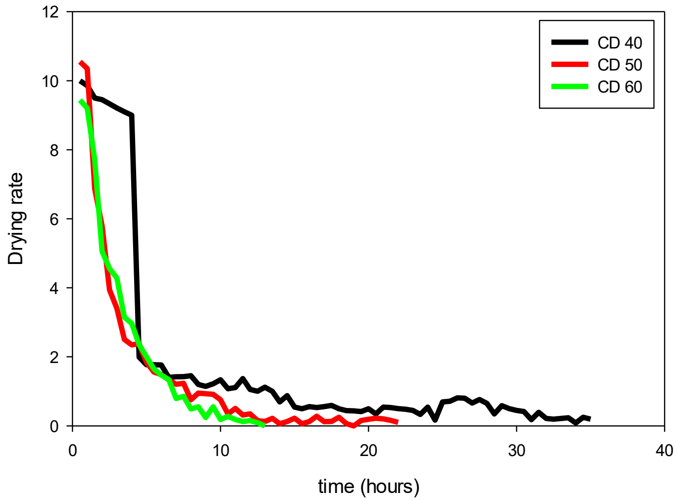

Figure 1. Curve of drying rate vs. time in cabinet dryer treatment. CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

Figure 2 shows the higher the temperature of the dryer used, the shorter the drying time will be, and the faster the decrease in water content will reach equilibrium. The increase in drying air temperature can reduce the time required to reach the humidity ratio starting from the heat transfer process in the drying chamber increases. An increase in temperature causes heat and mass transfer to increase as well, thus the water content of the material will decrease (Garavand *et al*., 2011).

Based on Figure 3, the increase in water content causes an increase in the drying rate as well, and the longer the drying time, the drying rate decreases. According to Thao and Noohorm (2011), the drying rate will decrease along with the drying process, this happens because less water is evaporated to the surface of the material. In Figure 3, it shows the distribution of the data

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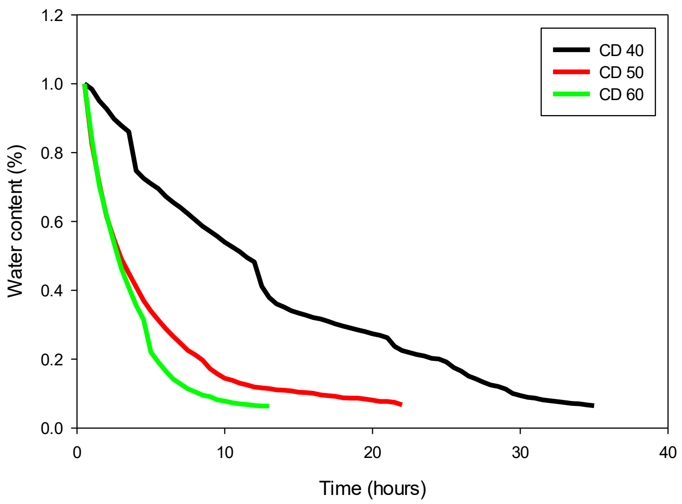

Figure 2. Curves ratio of moisture content vs. time in cabinet dryer treatment. CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

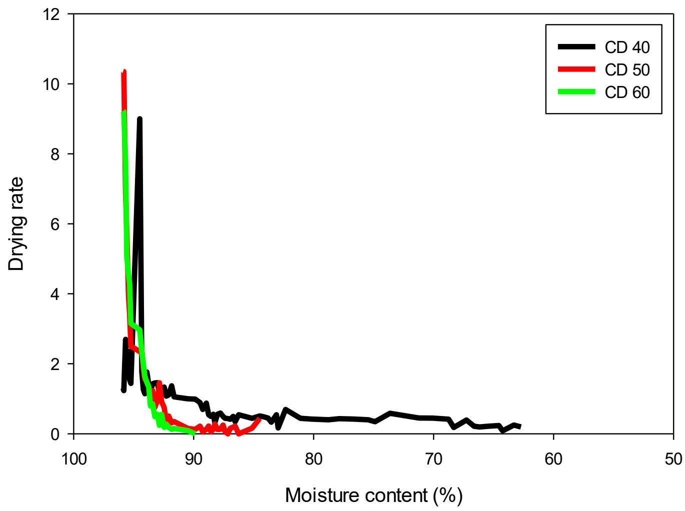

Figure 3. Curve of drying rate vs. moisture content in cabinet dryer treatment. CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

is irregular and it can be seen that at some points the water content should be low but the drying rate increases. This can happen, one of which is because the water that is evaporated to the surface of the material has run out while the water that has diffused into the material has not been maximally achieved (Humair, 2014). The fluctuations in this period do not form a balanced straight line. The rate will decrease steadily along with the decrease in the amount of water vapour that is evaporated at the end of the process. This is because the water content decreases due to heating. The drying rate decreases because the liquid composition is not evenly distributed in each part of the material, and this process will continue until it reaches the equilibrium moisture content (Porter *et al*., 1992). The high moisture content is accompanied by a high drying rate at the beginning of the process (Figure 3). This is by the theory which states that in the initial period of operation, the drying speed will increase rapidly, and then slowly decrease. This decrease can occur because the evaporation of water to the surface is greater than the rate of diffusion of water in the material to the surface. Furthermore, in the middle of the drying process, the drying rate will tend to be constant.

3.4 Shrinkage of flower

All drying methods can change the product's chemical and physical characteristics, though not always for the better (Anton, 2011; Punthi *et al*., 2022). The rate of product change during the drying is considered to be directly proportional to the length of the drying process (Risdianti *et al*., 2016). Some of the physical changes that can occur as a result of the drying process of food or agriculture include transformations starting from the shape, size, weight, and colour of the material (Culver and Wrolstad, 2008). The shrinkage of chrysanthemum flower dimensions was measured from the length and width of the flower and can be expressed in the form of a per cent and the depreciation refers to the drying research conducted on samples of roses, Imaniar (2020) found that the determination of the measurement of the length of the flower is because the flower can be said to have no volume. Although the colour of the chrysanthemum flowers after drying does not change much, there is still shrinkage because the surface of the chrysanthemum flower is smoother and thinner, evaporation of water causes shrinkage (Selvi *et al*., 2020). Based on Table 2, shows an increase in drying temperature, causing a decrease in the value of shrinkage in length and width. The difference in the value of shrinkage for each treatment can be caused by differences in the required drying time. The CD at 40°C takes longer than CD at 50°C and 60°C, while the temperature of 60°C requires the fastest drying time.

Table 2. Shrinkage of chrysanthemum flower.

Treatment	Shrinkage (%)	
	Long	Width
CD 40	25.05±4.97[a]	24.62±7.61[a]
CD 50	19.57±7.14[b]	18.00±4.14[b]
CD 60	18.17±5.49[b]	14.89±8.20[b]

Values are presented as mean±SD of triplicates, n = 3. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

3.5 Colour

Nielsen *et al*. (2003) found that the L* value is a value that indicates the brightness of the sample. A high value of L* means the sample is brightly coloured and the lower the value is, the sample is dark. The higher a* value indicates the sample is red, while the lower value indicates the sample is green. A lower b* value indicates a blue sample and higher b* value indicates a yellow

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Table 3. Colour analysis of chrysanthemum flower.

Treatment	L*	a*	b*	ΔE*
Fresh flower	77.30±1.59[c]	-9.76±1.47[a]	60.09±10.45[b]	21.32
CD 40	63.62±3.63[b]	1.25±0.63[c]	61.24±2.62[b]	19.83
CD 50	54.47±3.33[a]	2.72±0.34[cd]	49.21±3.13[b]	17.54
CD 60	51.75±1.20[a]	3.49±0.34[d]	51.01±2.11[b]	17.43
Commercial 1 day	65.38±3.32[b]	-0.96±0.39[b]	21.57±3.33[a]	16.80
Commercial 2 weeks	62.90±0.88[b]	-1.97±0.38[b]	25.97±2.75[a]	16.68

Values are presented as mean±SD of triplicates, n = 3. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

colour. Based on Table 3, shows a significant colour difference for each sample. The highest level of brightness (L*) was produced in fresh chrysanthemum flowers at 77.37, the highest level of redness (a*) in CD at 60°C was 3.48, and samples with the highest yellowness level (b*) in chrysanthemum dried at 40°C for 61.23. The drying process causes a brownish colour change due to enzyme damage (Syah, 2012). Fresh samples have the highest brightness level because they have not gone through a process that causes colour changes. Fresh chrysanthemum only goes through washing and withering for 24 h,rs it does not affect the changes in the ingredients. The yellow pigment in chrysanthemum flowers contains carotenoids such as lutein, β-carotene, and α-carotene, but the most dominant is β-carotene (Serlahwaty, 2007). Carotenoid colour pigments are easily damaged by acids, light, and high temperatures. Carotenoids are easily oxidized by oxygen, this is due to the instability of the polyene chain in its molecular structure (Dutta *et al*., 2005). According to Parinussa and Rondonuwu (2009), the geometric structure of carotenoids is dominated by the trans structure, and the structure is easily changed through the trans-cis isomerization process, along with the length of heating given and the high temperature used. During the heating process of the material, trans-cis isomerization occurs in the carotenoids, causing a decrease in carotenoids due to high temperatures (Worthington, 1988).

3.6 Antioxidant activity and total phenol content

Table 4 shows the antioxidant activity and total phenol, the commercial sample has the highest antioxidant activity and the lowest was obtained from the fresh chrysanthemum flower sample because fresh chrysanthemum still contains high water content compared to other samples. The phenol content of various treatments followed the trend in the antioxidant activity parameters. In the previous study, the longer drying time of the herbal drink of beluntas leaves and mint leaves caused a decrease in antioxidant activity. This is due to the occurrence of damage to compounds that act as antioxidants such as carotenoids and tannins, as a result of oxidation reactions (Apriliyani *et al*., 2021). Sivaci and Duman (2014) explain total phenol content and antioxidant activity has correlation, an increase in antioxidant activity in the material, and then an increase in total phenol content. The highest total phenol in the commercial chrysanthemum sample was 22.01%. According to Kahkonen *et al*. (2001), differences in the results of total phenol levels in chrysanthemum flowers can occur due to several factors, such as temperature, flower age, soil conditions used for planting, the intensity of fertilizer application, and environmental conditions. The components of phenolic compounds found in chrysanthemum flowers are flavonoids. Flavonoid compounds have a potentially important role in the development of chrysanthemum flowers into processed products such as medicines, food, and functional drinks (Yulianti, 2019). The role of phenol compounds in materials as antioxidants that can act in capturing various reactive compounds such as superoxide, hydroxyl, hypochlorous acid, and peroxyl radicals, by directly breaking free radical chain bonds (Nurmi, 2008). The drying techniques (freeze-drying, oven, and air) had a significant impact on the composition of the material. Heat treatment causes nonenzymatic browning reactions like oxidation, caramelization, and the Maillard reaction. Molecules with high antioxidant activity are created as a result of numerous nonenzymatic browning processes (Yudhistira *et al*., 2022).

Table 4. Antioxidant activity and total phenol of chrysanthemum flower.

Treatment	Antioxidant Activity	Total Phenol
Fresh flower	78.54±0.08[a]	2.74±0.57[a]
CD 40	81.12±0.01[a]	11.88±2.80[b]
CD 50	82.26±0.05[a]	14.92±3.70[bc]
CD 60	84.30±0.06[a]	15.17±1.11[bc]
Commercial 1 day	86.54±0.11[a]	22.01±2.36[bc]
Commercial 2 weeks	87.67±0.10[a]	19.78±2.45[c]

Values are presented as mean±SD of triplicates, n = 3. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

Table 5. Sensory evaluation of chrysanthemum flower brewed drink

Treatment	Organoleptic parameter				
	Flavour	Taste	Colour	After taste	Overall
CD 40	70.20±2.83[ab]	2.57±3.63[a]	78.47±2.56[ab]	3.03±3.03[ab]	65.43±2.83[ab]
CD 50	69.13±2.80[b]	3.13±3.13[b]	86.87±3.83[a]	3.27±3.26[b]	83.28±3.26[ab]
CD 60	84.65±3.20[a]	3.17±3.16[b]	80.80±3.70[ab]	3.20±3.20[b]	82.77±3.26[ab]
Commercial 1 day	82.82±2.80[ab]	2.97±2.70[ab]	66.40±3.33[ab]	2.70±2.83[a]	77.28±2.93[ab]
Commercial 2 weeks	70.70±1.11[ab]	2.70±0.90[ab]	64.97±2.01[b]	2.83±1.11[a]	68.73±1.00[ab]

Values are presented as mean±SD of triplicates, n = 3. Values with different superscripts within the same column are statistically significantly different ($p<0.05$). CD 40: cabinet dryer 40°C, CD 50: cabinet dryer 50°C, CD 60: cabinet dryer 60°C.

3.7 Sensory evaluation

Table 5 shows the sensory parameters of the chrysanthemum flower sample based on respondent assessment, the best results according to sensory analysis were samples of yellow chrysanthemum drink which were dried at 60°C. On the aroma and taste parameters, the highest score was in the sample of chrysanthemum flower drink which was dried at 60°C. Drying with a high temperature can remove the water content in the ingredients and when dry ingredients are brewed with hot water, the aroma and distinctive taste will likely come out. The highest colour score on the brew of the sample dried at 50°C almost resembled the drink from *Camelia sinensis*, hence it was preferred and understood as a good colour, compared to other steeping colours because other samples tended to be less concentrated and slightly yellowish. In the aftertaste and overall, the highest score was at CD 50°C. The aftertaste parameter can be influenced by the antioxidant content which can cause an astringent final taste. The results of the analysis of antioxidant content, at a temperature of 50°C tend to have 80% antioxidant activity, in consequence, the final taste is quite pronounced after drink. Overall parameter, the highest score is CD at 50°C can be concluded because the sample has the most similar colour and aftertaste to tea drink in general. Based on the results of this study, it is possible to determine the best process and results to obtain an efficient process based on each optimum process parameter (Sulaimana *et al.*, 2022).

4. Conclusion

The drying process has an influence on the physical and chemical quality of chrysanthemum flowers, such as changes in the compound content and sensory parameters. The length of the drying process also affects the drying rate, the longer the drying time, the lower the drying rate. It can be concluded that the best use of temperature and drying time is CD 60°C for 13 hrs. which produces chemical and sensory properties that are not significantly different from CD of 40°C and 50°C.

Conflict of interest

The authors declare no conflict of interest.

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