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Research Article

Formulation and Evaluation of Antidementia Tablets Containing Broccolli and Centella asiatica Extracts

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ABSTRACT

Broccoli is known to contain various bioactive compounds, particularly flavonoids and glucosinolates, which have potential antioxidant and neuroprotective properties. Meanwhile, gotu kola herb (Centella asiatica) contains flavonoid compounds and asiaticosides that are widely recognized for their role in improving cognitive function and supporting brain health. Based on these benefits, this study was conducted to formulate a combined tablet preparation containing broccoli extract and gotu kola herb extract. This study aims to determine the best tablet formulation by evaluating variations in the concentration of the binder PVP K-30, namely 2%, 3%, 4%, and 5%. The evaluation of tablet quality was carried out through several standard physical tests, including hardness testing, friability (brittleness) testing, and crushing time testing. In addition, this study also aimed to determine the dissolution profile of the tablets and to analyze the active substance profile by measuring the levels of flavonoid compounds and asiaticosides contained in the tablet formulation. Statistical analysis of the results demonstrated that all formulated tablets met the general requirements for good tablet quality. Among the tested formulations, formula 4 containing 5% PVP K-30 was identified as the best formula. This formulation showed tablet hardness values ranging from 5.07 to 8.12 kg, friability of 0.2022%, and crushing time between 05'00" and 09'30". The dissolution test results showed a dissolution rate of 87.2523% ± 0.8994. Furthermore, the flavonoid content in the tablets was found to be 5.53 mg QE/g ± 0.0391, while asiaticoside compounds were not detected in the tablet preparation.

Keywords: antidementia; asiaticosides; dissolution; flavonoids; PVP K-30

INTRODUCTION

Dementia is a condition characterized by a decline in cognitive function, memory, behavior, and social abilities that interferes with daily activities (Alzobaidi et al., 2021). The World Health Organization and Alzheimer's Disease International reported that the number of people living with dementia worldwide reached 47.5 million in 2015, with approximately 22 million cases occurring in Asia. In Indonesia, the number of People with Dementia (PwD) is projected to increase from 960,000 in 2013 to 3,980,000 by 2050 (Nurhikmah et al., 2025).

Broccoli and Centella asiatica have potential in the treatment and prevention of dementia. Broccoli (Brassica oleracea L.) is a plant containing glucosinolates, phenolic compounds, fiber, and antioxidant compounds. Broccoli is particularly rich in antioxidants such as sulforaphane. Sulforaphane, a hydrolysis product of glucoraphanin in broccoli, exhibits neuroprotective activity against neurodegenerative diseases (Kim, 2021).

In addition, broccoli contains high concentrations of bioactive compounds such as phenolics particularly flavonoids—which act as nutraceuticals. Flavonoids can inhibit nerve transmission by blocking enzymes necessary for neurotransmitter metabolism; these compounds play a key role in preventing neurodegenerative disorders such as Alzheimer's disease (Nagraj, 2020).

Centella asiatica contains various triterpenoid compounds, such as asiatic acid and asiaticoside, which function as brain supplements (Nurhikmah et al., 2025). Administration of Centella asiatica for 20 weeks has been reported to improve semantic fluency and visual memory in elderly women with dementia (Fitriana et al., 2021). Furthermore, the combination of

broccoli extract and Centella asiatica extract has demonstrated antidementia activity and has been shown to improve memory function in dementia-model mice (Sintya et al., 2025).

The utilization of broccoli extract and Centella asiatica extract will be further developed into tablet dosage forms. Tablets offer several advantages, including ease of administration, relatively accurate dosing, and good storage stability due to their dry form (Rijal et al., 2022; Saryanti & Saputri, 2022).

PVP K-30 is commonly used as a binder in tablet formulation. Granules containing PVP K-30 exhibit good flowability, a small angle of repose, produce fewer fine particles, and possess better compressibility (Saktiaji et al., 2024). PVP K-30 is widely used in tablet formulations because it can enhance tablet hardness and improve the physical quality of the preparation (Sari et al., 2023). Research conducted by Elmubarak et al. (2021) demonstrated that the use of PVP K-30 in tablet formulations improved dissolution characteristics and produced preparations with good quality, whereas Rijal et al. (2022) reported that the use of 5% PVP K-30 in tekelan leaf extract tablets produced tablet physical characteristics that met the required standards.

This study will combine broccoli extract and Centella asiatica extract into tablet dosage forms using different concentrations of PVP K-30 as a binder. Although previous studies have investigated broccoli extract, Centella asiatica extract, and the use of PVP K-30 separately in tablet formulations, studies on the formulation of combination tablets containing broccoli and Centella asiatica extracts using different concentrations of PVP K-30 are still limited. Furthermore, the effect of PVP K-30 concentration on tablet physical characteristics and active compound content has not been comprehensively evaluated. Therefore, this study aimed to formulate combination tablets containing broccoli and Centella asiatica extracts with various concentrations of PVP K-30 and evaluate their physical characteristics as well as flavonoid and asiaticoside contents.

METHODS

Instruments

Tablet press machine (Labtron®), oven (Memmer®), blender (Philips®), juicer (Philips®), dissolution tester (LID-6®), disintegration tester (LIJ-1®), flowability tester (Intralab®), friability tester (CS-2®), hardness tester (YD-2®), caliper, moisture balance (Optika Italy®), tapped density tester (tdt-1h®), standard laboratory glassware (Pyrex®), analytical balance (Lab Pro®), vacuum evaporator (Jasco V-730®), UV-Vis spectrophotometer (Jasco V-730®), and High-Performance Liquid Chromatography (Hitachi L2000®).

Materials

Fresh broccoli, fresh *Centella asiatica*, PVP K-30 (Mepro, Indonesia), Avicel PH 102, Ac-Di-Sol, Magnesium Stearate, Friability, Aquadest, Sodium Acetate (Merck, Jerman), Quercetin (Sigma, US), Methanol pro analysis (Merck, Jerman), $AlCl_3$ 10% (Merck, Jerman), Ethanol 70%, KH_2PO_4 0.2M (Merck, Jerman), and NaOH 0.2N (Merck, Jerman).

Methods

Preparation of Dried Extract of Broccoli and Centella asiatica

The manufacture of dried broccoli extract is carried out using a juicer until a filtrate is obtained, then the pulp is re-juiced with water and filtered. The filtrate obtained is then dried with a vacuum dryer at 50°C for 4 hours until a dry extract is obtained. Meanwhile, *Centella asiatica* are mashed using a blender with a ratio of 1:1.5 water and put in a juicer until filtrate is obtained. All filtrates are dried using a vacuum evaporator with a temperature of 50°C for 6 hours until a dry extract is obtained. Testing the physical quality characteristics of dried broccoli extract and CA includes organoleptic, moisture content, and ash content tests.

Determination of Total Flavonoid Levels of Dry Extracts

The determination of flavonoid content was carried out using the colorimetric method described by Situmorang et al. (2022) to determine the total flavonoid content. The combined weight of both extracts was 190 mg, while the weight of each individual extract was 95 mg. The sample was dissolved in 25 mL of methanol and shaken for 10 minutes. Subsequently, 2.5 mL of the solution was transferred into a 25 mL volumetric flask. The sample was then added with 1 mL of 10% $AlCl_3$ and 1 mL of 1 M sodium acetate, followed by the addition of distilled water up to the calibration mark, and the mixture was homogenized thoroughly. After incubation for the optimum incubation time, the absorbance was measured using a UV-Vis spectrophotometer at the maximum wavelength. The absorbance values were substituted into the regression equation of the quercetin standard curve, and the total flavonoid content was subsequently calculated using Equation (1).

$$\text{Rate}\left(\text{mg}\frac{\text{QE}}{\text{g}}\right) = \frac{\text{Csampel (ppm)(Volume (L))(fp)}}{\text{Sampel weight (g)}} \quad .....(1)$$

Table 1. Formulation of broccoli and *Centella asiatica* (ca) extract combination tablet

Material	Function	Formula (% b/b)			
		1	2	3	4
Dried broccoli extract	Active	12.67	12.67	12.67	12.67
Dried extract of CA	Substances	12.67	12.67	12.67	12.67
PVP K-30	Binder	2	3	4	5
Ac-Di-Sol	Disintegrant	3	3	3	3
Magnesium stearate	Lubricant	2	2	2	2
Friability	Glidant	2	2	2	2
Avicel PH 102 ad	Fillers	100	100	100	100

Tablet Manufacturing

Combination tablets containing broccoli extract and *Centella asiatica* extract were prepared in four formulations using different concentrations of PVP K-30 as a binder, namely F1 2%, F2 3%, F3 4%, and F4 5%. Each tablet had a weight of 750 mg and contained 95 mg of broccoli extract and 95 mg of Centella asiatica extract (12.67%). Each formulation was prepared in a batch size of 500 tablets. The amount of broccoli extract and Centella asiatica extract (95mg) was selected based on the effective dose reported by Hidayat, et. al., 2023. The tablet formulations are presented in Table 1.

Tablet preparation was carried out using the wet granulation method. The PVP K-30 binder solution was dissolved in 70% ethanol for 24 hours until a viscous solution was formed while being covered with aluminium foil. Dried broccoli extract, *Centella asiatica* extract, Ac-Di-Sol, and Avicel PH 102 were weighed according to the formulation. All materials were mixed until a homogeneous blend was obtained. The PVP K-30 solution was then added to the powder mixture until a granulated mass was formed. The resulting granules were sieved using an 8-mesh sieve and subsequently dried in an oven at 40–60°C until dry granules were obtained. The dried granules were re-sieved using a 16-mesh sieve, followed by moisture content testing. Magnesium stearate and talc were then mixed with the dried granules until homogeneous. Subsequently, granule quality evaluation, tablet compression, and tablet quality evaluation were carried out.

Granule Quality Evaluation

Granule quality evaluation included organoleptic testing with parameters consisting of aroma, taste, color, and shape; moisture content testing using a moisture balance; flow rate and angle of repose testing using a flowability tester; and compressibility and Hausner ratio testing using a tapped density tester.

Tablet Quality Evaluation

Tablet quality evaluation included organoleptic testing, weight and size uniformity testing, hardness testing, friability testing, disintegration time testing, and dissolution testing.

Determination of Total Flavonoid Levels in Tablets

A total of 20 tablets from each formulation were finely powdered and weighed equivalent to 190 mg of the total extract content. Methanol was added into a 25 mL volumetric flask up to the calibration mark, and the solution was stirred for 20 minutes using a magnetic stirrer, followed by filtration. Subsequently, 2.5 mL of the filtrate was transferred into a 25 mL volumetric flask, followed by the addition of 1 mL of 10% $AlCl_3$ and 1 mL of 1 M sodium acetate, and then diluted with distilled water up to the calibration mark. The solution was shaken, allowed to stand for the optimum incubation time, and the absorbance was measured at the maximum wavelength using a UV-Vis spectrophotometer.

Determination of Asiaticoside Levels in Tablets

Asiaticoside content was determined using an HPLC Hitachi L-2000 system equipped with a Zorbax Eclipse C18 column. The mobile phase consisted of acetonitrile and distilled water using a gradient elution program of 20–35% acetonitrile for 15 min, followed by 55% acetonitrile for 5 min. Detection was performed at a wavelength of 206 nm, and the injection volume was 20 µL. The sample was prepared by weighing 1 g of powdered tablet into a vial, adding 8 mL of 70% methanol, sonicating for 30 min, allowing it to stand for 15 min, followed by a second sonication for 30 min. The solution was transferred into a 10 mL volumetric flask and diluted to volume with 70% methanol. After filtration through a 0.45 µm filter, 20 µL of the filtrate was injected into the HPLC systemThe obtained results were expressed in mg/g.

RESULTS AND DISCUSSION

Characteristics of Extracts

Broccoli and *Centella asiatica* were extracted using an extraction method involving blending and juicing techniques. This technique was selected because it is relatively rapid and capable of extracting compounds efficiently while minimizing exposure to oxygen (Aminah et al., 2023; Sun et al., 2025). A total of 10,500 g of broccoli juice produced a dry extract

yield of 2.76%, whereas 17,035 g of Centella asiatica juice produced a dry extract yield of 1.38%. The dried extracts are presented in Figure 1.

(a) (b)

Figure 1. Dry Broccoli extract (a), Dry *Centella asiatica* extract (b)

The quality characteristics of the extracts included organoleptic evaluation, moisture content determination, and ash content determination. Organoleptic observations of the broccoli extract showed that it was in the form of a fine powder, brown in color, possessed a strong characteristic aromatic odor, and had a bitter taste. Meanwhile, the Centella asiatica extract was observed as a fine powder with a dark green color, a weak characteristic odor, and a bitter taste.

The acceptable moisture content requirement for extracts is generally less than 10% (Yuliana, 2023). The obtained moisture content of broccoli extract was 9.03% ± 0.0553, while that of *Centella asiatica* extract was 8.79% ± 0.2247, indicating that both extracts fulfilled the required moisture content standards. The ash content of broccoli extract was 8.53% ± 0.4067 (requirement: not more than 10.2%), whereas the ash content of Centella asiatica extract was 8.75% ± 0.0961 (requirement: not more than 16.6%). Therefore, the ash content values obtained from both extracts met the specified requirements.

Total Flavonoid Content in the Extracts

The determination of total flavonoid content in the extracts was carried out using the colorimetric method with $AlCl_3$ and sodium acetate as color-forming reagents. The maximum wavelength obtained was 434.5 nm. The total flavonoid content was expressed in mg QE/g sample. The total flavonoid content obtained for broccoli extract was 5.75 mg QE/g ± 0.0104, while Centella asiatica extract contained 4.98 mg QE/g ± 0.0210, and the combined extract contained 6.33 mg QE/g ± 0.0040.

Granule Quality Evaluation

Combination tablets containing broccoli extract and *Centella asiatica* extract were prepared in four formulations with different concentrations of PVP K-30 binder. Each tablet had a weight of 750 mg, with a batch size of 500 tablets. The tablets were prepared using the wet granulation method to improve the flow properties of the granules. Organoleptic observations of the granules from each formulation showed a light brown color, a strong characteristic broccoli aroma, a bitter taste, and a fine granular form.

The evaluation results demonstrated good granule characteristics, and statistical analysis using SPSS indicated that there was no significant effect of different PVP K-30 binder concentrations on the granule evaluation parameters. The results of granule evaluation are presented in Table 2.

Table 2. Results of the Quality Evaluation of Granules Combining Broccoli and Centella asiatica Extracts

Formula Tablets	Moisture Content (%)	Flow Rate (g/s)	Angle of Repose (°)	Bulk Density (g/mL)	Tap Density (g/mL)	Compression Index (%)	Hausner Rasio
F1 (PVP K-30 2%)	3.51±0.24	7.55^{a}±0.61	22.30^{a}±0.21	0,45 0,45 0,45	0,5 0,5 0,49	9.39^{a}±1.06	1,10^{a}±0,01
F2 (PVP K-30 3%)	3.53±0.02	7.44^{a}±0.45	23.46^{ab}±0.98	0,44 0,45 0,45	0,47 0,50 0,48	7.54^{a}±2.13	1.08^{a}±0.03
F3 (PVP K-30 4%)	3.22±0.09	7.53^{a}±0.26	20.25^{a}±1.74	0,57 0,57 0,53	0,60 0,61 0,57	6.19^{a}±1.06	1.07^{a}±0.01
F4 (PVP K-30 5%)	3.29±0.4	7.08^{a}±0.31	19.95^{a}±1.71	0,60 0,66 0,63	0,64 0,74 0,69	8.59^{a}±2.28	1.09^{a}±0.03

Caption: Treating with the same superscript means no real difference, while treating with a different superscript means there is a real difference

Table 3. Uniform results of tablet weight and size

Formula Tablets	Weight Uniformity		Size Uniformity (%)	
	Average (mg)	Range (mg)	Thickness (cm)	Diameter (cm)
F1 (PVP K-30 2%)	751.53 ± 6.28	741.4 – 758.6	0.61 ± 0.00	1.2 ± 0.00
F2 (PVP K-30 3%)	754.70 ± 3.83	750.1 – 762.3	0.61 ± 0.00	1.2 ± 0.00
F3 (PVP K-30 4%)	758.18 ± 4.51	752.1 – 765.5	0.61 ± 0.00	1.2 ± 0.00
F4 (PVP K-30 5%)	756.365 ± 2.51	750.2 – 759.8	0.61 ± 0.00	1.2 ± 0.00

Tablet Quality Evaluation

The combination tablets containing broccoli extract and *Centella asiatica* prepared using the wet granulation method, exhibited relatively similar organoleptic characteristics due to the use of the same concentration of active ingredients. The resulting tablets were round with flat surfaces, light brown in color with dark brown speckles, possessed a strong characteristic broccoli odor, and had a bitter taste. The appearance of the tablets is presented in Figure 2.

F1 (PVP K-30 2%)

F2 (PVP K-30 3%)

F3 (PVP K-30 4%)

F4 (PVP K-30 5%)

Figure 2. Combination tablets of broccoli extract and CA

The weight uniformity results demonstrated that all formulations complied with the requirements specified in the Indonesian Pharmacopoeia, 6th edition. Uniform tablet weight influences the accuracy of the dose administered to the body, thereby ensuring the expected therapeutic effect is achieved. Size uniformity testing was conducted to ensure that the tablets possessed consistent thickness and diameter. According to the Indonesian Pharmacopoeia, 5th edition, the tablet diameter must not exceed three times and must not be less than 1⅓ times the tablet thickness. Differences in binder concentration did not affect tablet thickness and diameter; therefore, all formulations produced tablets with similar thickness and diameter. The results of tablet weight uniformity are presented in Table 3.

Tablet hardness, friability, and disintegration time are important parameters in determining tablet quality. A good tablet formulation must comply with the required physical quality standards (Caren, 2023; Yus'ady & Sulistyowati, 2024). The results of tablet hardness, friability, and disintegration time testing are presented in Table 4.

The hardness test results showed that formulations F2, F3, and F4 complied with the requirements reported by Maulana et al. (2025), which stated that acceptable tablet hardness ranges from 4–8 kp. In contrast, formulation F1 did not meet the required hardness criteria. These findings indicate that the concentration of PVP K-30 binder influenced tablet hardness.

The friability test results demonstrated that all formulations met the requirements specified by the USP (2024), which states that tablet friability should not exceed 1%. Differences in tablet friability values were influenced by the binding strength of the binder. This finding is consistent with the study conducted by Indra et al. (2025), which reported that higher concentrations of PVP K-30 resulted in lower tablet friability values. Stronger granules produced harder tablets with lower friability.

The disintegration time results showed that all formulations complied with the disintegration requirements for uncoated tablets according to the Indonesian Pharmacopoeia, 6th edition, which specifies a disintegration time of less than 15 minutes. However, the disintegration time varied among formulations. Higher concentrations of PVP K-30 prolonged the disintegration time because higher binder concentrations possess stronger binding properties (Aprilliyani et al., 2024).

Table 4. Result hardness, friability, and disintegration time

Formula Tablets	Hardness (kp)		Friability (%)	Disintegration Time	
	Range	Average		Range	Average
F1	2,86 - 4,49	$3,46^{a} \pm 0,36$	$0,7495^{c} \pm 0,0347$	01'04" – 02'51"	$01'52"^{a} \pm 0,53$
F2	3,99 - 5,94	$4,74^{b} \pm 0,50$	$0,3717^{b} \pm 0,0384$	02'32" – 05'48"	$04'18"^{b} \pm 0.87$
F3	4.52 - 7,49	$5,68^{c} \pm 0,70$	$0,3193^{b} \pm 0,0649$	04'15" – 07'50"	$05'65"^{c} \pm 1,09$
F4	5,07 - 8,12	$6,10^{d} \pm 0,98$	$0,2022^{a} \pm 0,0492$	05'00" – 09'30"	$07'03"^{d} \pm 1,50$

Caption: Treating with the same superscript means no real difference, while treating with a different superscript means there is a real difference

Tabel 5. Dissolution Test Results for Combination Tablets of Broccoli and *Centella asiatica* Extracts

Times (Minutes)	Percentage of Drug Release (%)			
	F1	F2	F3	F4
5	49.7028 ± 0.0069	52.1767 ± 0.5316	66.4328 ± 1.0959	46.5704 ± 4.0770
10	53.4150 ± 0.7984	54.5380 ± 2.9029	70.2327 ± 0.9270	70.4055 ± 0.1028
15	57.8584 ± 3.1713	58.6717 ± 2.3718	72.2488 ± 0.5309	74.6344 ± 1.6160
30	60.0519 ± 0.6599	61.6867 ± 2.4661	73.8964 ± 0.4734	76.3610 ± 2.6003
45	63.4306 ± 0.7724	64.4082 ± 2.1831	77.6942 ± 0.4986	81.3380 ± 1.6302
60	66.2214^{a} ± 1.4142	71.7533^{b} ± 1.9079	81.9345^{c} ± 1.1803	87.2523^{d} ± 0.8994

Caption: Treating with the same superscript means no real difference, while treating with a different superscript means there is a real difference

Tablet dissolution testing was conducted to evaluate drug release by observing the release profile of the active compounds in the dissolution medium over a specified period (Galata et al., 2021; Fatmi et al., 2023). The dissolution test was performed using 250 mL of phosphate buffer (pH 6.8) at 37°C and a stirring speed of 100 rpm for 60 minutes. The dissolution time was set at 60 minutes because, according to the Indonesian Pharmacopoeia, a drug that meets the requirements must release at least 85% of its active ingredient. Based on the results obtained in this study, the drug released its active ingredient at the 60-minute mark. The highest percentage of active compound release at the 60th minute was observed in formulation F4.

Although increasing the concentration of PVP K-30 generally increases tablet hardness and prolongs disintegration time, formulation F4 showed the highest dissolution rate. This phenomenon suggests that dissolution behavior is not solely dependent on hardness and disintegration time. PVP K-30 is a hydrophilic polymer that enhances tablet wettability and promotes water penetration into the tablet matrix, thereby facilitating drug release. In addition, PVP K-30 may improve the dispersion of flavonoids within the tablet system and form a more amorphous-like distribution of the active compounds, which increases their solubility and dissolution rate. Therefore, despite the higher hardness and longer disintegration time, formulation F4 exhibited improved dissolution due to the combined effects of increased wettability and improved drug dispersion. The dissolution profile is presented in Figure 3.

According to the Indonesian Pharmacopoeia, 6th edition, the requirement for active compound release is that more than 85% of the active compound must be dissolved. The highest active compound release obtained was 87.2523%, indicating that the tablet dissolution results complied with the required standard. The dissolution results are presented in Table 5.

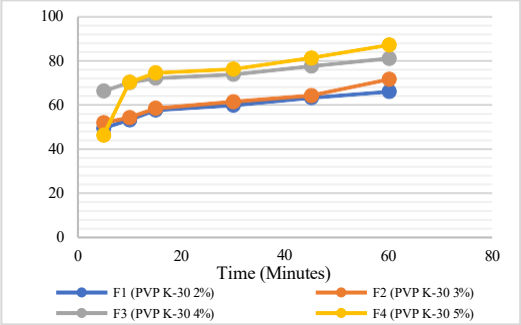

Figure 3. Tablet dissolution profile

Total Flavonoid Levels in Tablets

Total flavonoid content determination was conducted to quantify the flavonoid content present in the tablet formulation. Based on the obtained data, the flavonoid content of formulation 1 (2% PVP K-30) was 4.39 ± 0.0837 mg QE/g, formulation 2 (3% PVP K-30) was 4.62 ± 0.0200 mg QE/g, formulation 3 (4% PVP K-30) was 4.97 ± 0.0344 mg QE/g, and formulation 4 (5% PVP K-30) was 5.53 ± 0.0391 mg QE/g.

The flavonoid content in combination tablets containing broccoli and Centella asiatica extracts showed a tendency to increase as the concentration of PVP K-30 increased. This increase is thought to be related to the hydrophilic nature of PVP K-30, which enhances the tablets wettability, thereby accelerating the penetration of the dissolution medium into the tablet matrix. This facilitates the disintegration process and the release of flavonoids from the formulation, resulting in higher amounts of dissolved and measured flavonoids during testing.

Thus, the observed increase in flavonoid levels does not indicate an increase in the flavonoid content within the tablets but rather reflects more optimal flavonoid release due to improved dissolution capacity. These findings are consistent with those of Noval (2021), who reported that increasing the concentration of PVP K-30 as a binder can enhance the dissolution rate of tablets due to its hydrophilic nature, which

facilitates water penetration into the tablet.

Although sulforaphane is recognized as the principal neuroprotective compound in broccoli, it was not analyzed in this study because of its instability during processing and the need for more specific analytical methods. Therefore, total flavonoid content was used as a complementary phytochemical parameter to support the phytochemical evaluation of the formulated tablets. Although not the primary marker of broccoli, flavonoids possess antioxidant and neuroprotective properties that may contribute to the potential antidementia activity of the combined broccoli and *Centella asiatica* extracts. Further studies are required to quantify sulforaphane and better characterize the active compounds responsible for the antidementia potential of the formulation.

Asiaticoside Levels in Tablets

Asiaticoside content determination was performed to evaluate the asiaticoside content present in the tablets. According to the Indonesian Herbal Pharmacopoeia, 2nd edition, *Centella asiatica* herbal material should contains not less than 0.90% asiaticoside as one of its quality markers. However, the results of asiaticoside analysis conducted at Biofarmaka IPB showed that asiaticoside was not detected in the tablet samples. These results indicate that the asiaticoside concentration was below the method's limit of detection or was not detected under the analytical conditions used.

Several factors may have contributed to the absence of detectable asiaticoside, including a low asiaticoside content in the *Centella asiatica* extract, possible degradation during the extraction and tablet manufacturing processes, interactions with other formulation components, or limitations of the analytical method used. Since asiaticoside analysis was performed only on the final tablet and not on the raw extract prior to formulation, the exact cause of its absence could not be conclusively determined. Therefore, further studies are needed to quantify asiaticoside in the raw extract before formulation and to evaluate its stability throughout the manufacturing process to confirm its presence in the final dosage form.

CONCLUSION

Broccoli and *Centella asiatica* extracts were successfully formulated into tablets with acceptable physical quality using different concentrations of PVP K-30 as a binder. These findings demonstrate that PVP K-30 concentration influences the physical characteristics, dissolution behavior, and flavonoid release of the tablets. Formula 4 with PVP K-30 5% is the best formula with a hardness of 5.07 – 8.12 kp, a brittleness of 0.2022%, and a disintegration time of 05'00" – 09'30". Formula 4 exhibited a dissolution rate of 87.2523% ± 0.8994 and a flavonoid level of 5.53 mg/QE g ± 0.0391. These findings indicate that the formulation has the potential to be further developed as a herbal tablet dosage form for cognitive health support. However, further pharmacological and stability studies are required to confirm its antidementia efficacy and long-term quality.

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