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# Anti-inflammatory Activity of *Ipomoea batatas* Leaves Ethanolic Extract Tablet with Variation of Polyvinylpyrrolidone and Amylum Binders

[Aktivitas Antiinflamasi Tablet Ekstrak Etanol Daun *Ipomoea batatas* dengan Variasi Pengikat Polivinilpirolidon dan Amilum]

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**ABSTRACT**

Purple sweet potato (*Ipomoea batatas* (L.) Lam.) leaves are traditionally used as an anti-inflammatory remedy. This study investigated the anti-inflammatory activity of purple sweet potato leaf ethanolic extract and its formulation into tablet dosage forms with varying concentrations of polyvinylpyrrolidone and amylum as binders. The extract was obtained through maceration using 96% ethanol and tested for anti-inflammatory activity using the bovine serum albumin denaturation method. The extract showed strong anti-inflammatory activity with an $IC_{50}$ value of 62.628 ppm compared to sodium diclofenac with an $IC_{50}$ of 57.326 ppm. The extract was then formulated into tablets with binder ratios of 1:0, 0:1, 1:1, 2:3, and 1:4 (polyvinylpyrrolidone: amylum) using wet granulation. Evaluation of physical properties indicated that the 1:1 binder ratio produced tablets that met quality requirements, including hardness, friability, and disintegration time. These results suggest that *I. batatas* leaf extract has potent anti-inflammatory properties and is suitable for development into a tablet formulation with appropriate binder ratios.

**ABSTRAK**

Daun ubi jalar ungu (*Ipomoea batatas* (L.) Lam.) secara tradisional digunakan sebagai obat antiinflamasi. Penelitian ini bertujuan untuk mengetahui aktivitas antiinflamasi dari ekstrak etanol daun ubi jalar ungu serta formulasi tablet dengan variasi konsentrasi pengikat polivinilpirolidon dan amilum. Ekstrak diperoleh dengan metode maserasi menggunakan etanol 96% dan diuji aktivitas antiinflamasinya menggunakan metode penghambatan denaturasi albumin serum sapi. Hasil menunjukkan bahwa ekstrak memiliki aktivitas antiinflamasi yang kuat dengan nilai $IC_{50}$ sebesar 62,628 ppm, dibandingkan natrium diklofenak sebesar 57,326 ppm. Ekstrak kemudian diformulasikan dalam bentuk tablet dengan rasio pengikat polivinilpirolidon:amilum sebesar 1:0, 0:1, 1:1, 2:3, dan 1:4 melalui metode granulasi basah. Evaluasi sifat fisik menunjukkan bahwa rasio pengikat 1:1 menghasilkan tablet dengan mutu fisik yang memenuhi persyaratan, termasuk kekerasan, kerapuhan, dan waktu hancur. Hasil ini menunjukkan bahwa ekstrak daun *I. batatas* memiliki potensi antiinflamasi yang kuat dan layak diformulasikan dalam bentuk sediaan tablet dengan rasio pengikat yang sesuai.

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## 1. INTRODUCTION

Inflammation is a biological defense mechanism triggered by tissue damage due to physical trauma, exposure to harmful chemicals, or microbial infection. Common manifestations of inflammation include pain, redness, swelling, and impaired tissue function. Although inflammation is a protective response,

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prolonged or excessive inflammation can lead to various chronic conditions (Ramadhani & Sumiwi, 2016).

The adverse effects associated with prolonged use of synthetic anti-inflammatory drugs, such as gastrointestinal irritation and organ toxicity, have encouraged the search for safer alternatives derived from natural products (Kurnia et al., 2019). One such candidate is the purple sweet potato (*Ipomoea batatas* (L.) Lam.) leaf, which is traditionally used for its antioxidant and anti-inflammatory properties. Traditionally, the leaves are consumed by boiling or pounding, but this method often fails to mask their naturally bitter taste, making them less palatable for long-term use (Waluyo et al., 2021).

To improve the acceptability and stability of the active compounds, purple sweet potato leaves can be processed into ethanolic extracts and formulated into solid dosage forms such as tablets. Tablets are widely used due to their ease of administration, precise dosing, and long shelf life. However, one of the formulation challenges lies in achieving sufficient tablet hardness and integrity, which largely depends on the concentration and type of binder used (Sari et al., 2021).

Common binders include natural starches such as amylum and synthetic agents such as polyvinylpyrrolidone (PVP). Amylum, often used in the form of mucilago amili at concentrations of 5–10%, and PVP at concentrations of 0.5–5%, play a critical role in forming stable granules during wet granulation and ensuring proper tablet cohesion (Kurakula & Rao, 2020).

This study aimed to evaluate the anti-inflammatory activity of *I. batatas* leaf ethanolic extract and determine its suitability for tablet formulation. Furthermore, it assessed the effect of varying concentrations of polyvinylpyrrolidone and amylum binders on the physical characteristics of the resulting tablets.

## 2. METHOD

### 2.1. Materials

The materials used in this study included purple sweet potato (*I. batatas*) leaves collected from Kandangserang District, Pekalongan Regency with coordinates 7°11'41.8"S 109°32'59.1"E and an altitude of approximately 900 mdpl.

Additional substances included 96% ethanol, polyvinylpyrrolidone (PVP, food grade), amylum manihot (food grade), primogel, lactose, magnesium stearate, talcum, distilled water, sodium diclofenac (p.a., Sigma-Aldrich), Tris Buffer Saline (TBS, p.a., Sigma-Aldrich), and bovine serum albumin (BSA, p.a., Sigma-Aldrich).

### 2.2. Sample Collection and Extraction

Fresh leaves were cleaned and dried in an oven at 50°C for approximately two days and then ground into simplicia powder (Waluyo et al., 2021). Extraction was performed by macerating the simplicia with 96% ethanol in a ratio of 1:5 (w/v) for five days, with daily stirring for one hour. The filtrate was concentrated using a rotary evaporator at 40°C and thickened further in an oven at the same temperature (Waluyo et al., 2021; Okta & Laili, 2023).

### 2.3. Phytochemical Screening

Phytochemical screening of the extract aimed to detect alkaloids, flavonoids, terpenoids, steroids, tannins, and saponins. Alkaloid identification was carried out using Mayer, Wagner, and Dragendorff reagents. Flavonoid detection involved the use of magnesium powder and concentrated HCl after dissolution in methanol. Terpenoid and steroid presence was evaluated by mixing the extract with chloroform and acetic anhydride, then layering it with concentrated sulfuric acid. Tannins were detected by adding 1% $FeCl_3$ to the aqueous extract, while the frothing method was used for saponin detection (Setyowati et al., 2014 ; Pramiastuti & Murti, 2022).

### 2.4. Anti-Inflammatory Assay

Anti-inflammatory activity was determined by the inhibition of protein denaturation using the bovine serum albumin method (Farida et al., 2018). Tris Buffer Saline was prepared by dissolving 4.35 g of NaCl and 605 mg of Tris base in distilled water, adjusting the pH to 6.3 with glacial acetic acid, and completing the volume to 500 mL. A 0.2% BSA solution was prepared by dissolving 200 mg of BSA in 100 mL of TBS. The ethanolic extract was dissolved in distilled water at 1000 ppm and diluted to concentrations of 80, 40, 20, 10, and 5 ppm (Waluyo et al., 2021). Sodium diclofenac was used as a positive control at 1000 ppm and serially diluted to 100, 50, 25, 12.5, 6.25, and 3.13 ppm. For each test, 500 µL of the solution was added to BSA and incubated at 25°C for 30 minutes, then heated in a water bath at 72°C for 5 minutes and cooled at room temperature for 25 minutes. Absorbance was measured at 660 nm. The percentage inhibition was calculated using the formula:

$$\text{Inhibition} = \left(\frac{A_{control} - A_{sample}}{A_{control}}\right) \text{ x } 100\%$$

where A control is the absorbance of the negative control (BSA without sample), and A sample is the absorbance of the test solution. The concentration of the sample required to inhibit 50% of protein denaturation ($IC_{50}$) was determined by plotting the inhibition percentages against sample concentrations and applying linear regression analysis. The $IC_{50}$ value was obtained by substituting 50 into the regression equation and solving for the corresponding concentration.

### 2.5. Tablet Formulation

Tablet formulation was conducted using the wet granulation method. Each formula contained 35% extract and varying concentrations of PVP and amylum as binders (**Table 1**). Additional ingredients included primogel (3%), magnesium stearate (2%), talcum (1%), and lactose as filler up to 500 mg. The dry mixture was moistened with distilled water, sieved through mesh no. 12, dried at 50°C, and sieved again using mesh no. 18 prior to compression (Siregar & Wikarsa, 2008).

**Table 1.** Composition of *I. batatas* ethanolic extract tablet formulations

| Ingredient | Function | F1 (%) | F2 (%) | F3 (%) | F4 (%) | F5 (%) |
|---|---|---|---|---|---|---|
| Ethanolic extract of *I. batatas* leaf | Active compound | 35 | 35 | 35 | 35 | 35 |
| Polyvinylpyrrolidone (PVP) | Binder | 5 | 0 | 5 | 4 | 2 |
| Amylum manihot | Binder | 0 | 10 | 5 | 6 | 8 |
| Primogel | Disintegrant | 3 | 3 | 3 | 3 | 3 |
| Lactose | Filler | ad 500 mg | ad 500 mg | ad 500 mg | ad 500 mg | ad 500 mg |
| Magnesium stearate | Lubricant | 2 | 2 | 2 | 2 | 2 |
| Talcum | Lubricant | 1 | 1 | 1 | 1 | 1 |

### 2.6. Granule and Tablet Evaluation

Granules were evaluated for flow properties, including flow time, angle of repose, and compressibility index. Flow time was measured by recording the time for 100 g of granules to flow through a funnel. The angle of repose was determined by allowing the granules to form a cone and measuring the angle formed. Compressibility index was calculated from bulk and tapped volume data (Lachman et al., 1994; Siregar & Wikarsa, 2008).

Tablets were evaluated based on organoleptic characteristics, weight variation, diameter and thickness, hardness, friability, and disintegration time. Organoleptic properties were visually assessed. Weight and size were measured using a digital scale and caliper. Hardness was measured using a tablet hardness tester. Friability was assessed using a friabilator set at 25 rpm for 4 minutes. Disintegration time was determined using a disintegration tester with water at 37°C as the medium (Depkes RI, 1979; 2014; 2020).

### 2.7. Data Analysis

All quantitative results were analyzed using one-way ANOVA with a 95% confidence interval. If significant differences ($p < 0.05$) were found among formulations, Tukey's post hoc test was applied to identify the specific differences between groups.

## 3. RESULTS AND DISCUSSION

### 3.1. Extraction Yield and Phytochemical Screening

The extraction of *Ipomoea batatas* leaf simplicia using 96% ethanol through maceration yielded 54.45 g of thick extract from 650 g of dried material, resulting in an extractive yield of 8.37%. The moisture content of the extract was 17.47%, which falls within the acceptable range of 5–30% for solid preparations, indicating its suitability for further formulation (Voight, 1995).

Phytochemical screening was performed to qualitatively determine the presence of secondary metabolites in the ethanolic extract. The outcomes of the screening are presented in **Table 2**. The results confirmed the presence of alkaloids, flavonoids, terpenoids, steroids, tannins, and saponins, which are compounds commonly associated with pharmacological activities. Flavonoids, in particular, are well documented for their anti-inflammatory and antioxidant properties. These results are in line with previous studies that reported similar phytochemical profiles for *I. batatas* extracts (Setyowati et al., 2014; Pramiastuti & Murti, 2022; Lidyawati et al., 2021). The presence of multiple bioactive constituents supports the therapeutic potential of the extract, especially in anti-inflammatory applications.

**Table 2**. Phytochemical screening results of *I. batatas* ethanolic leaf extract

| Phytochemical | Test Method | Result | Indicator |
|---|---|---|---|
| Alkaloids | Mayer, Wagner, Dragendorff | + | White precipitate, brown and orange color |
| Flavonoids | Magnesium and HCl reaction | + | Dark reddish color |
| Terpenoids | Acetic anhydride and $H_2SO_4$ | + | Red color |
| Steroids | Acetic anhydride and $H_2SO_4$ | + | Green color |
| Tannins | $FeCl_3$ 1% | + | Blackish green color |
| Saponins | Foam test | + | Stable foam for >10 minutes |

### 3.2. Anti-inflammatory Activity

The anti-inflammatory activity of the test samples was evaluated through inhibition of protein denaturation using bovine serum albumin. This method is based on the principle that anti-inflammatory agents can inhibit the denaturation of proteins induced by heat. The percentage of inhibition was measured for both sodium diclofenac as the positive control and the ethanolic leaf extract of *I. batatas* across various concentrations.

As shown in **Figure 1a**, sodium diclofenac demonstrated a dose-dependent increase in inhibition percentage, with the highest effect observed at 100 ppm. Linear regression analysis yielded an $IC_{50}$ value of 57.33 ppm, indicating strong anti-inflammatory activity. This value aligns with those reported in previous studies, where sodium diclofenac typically shows potent inhibition in protein denaturation assays (Farida et al., 2018).

In parallel, the ethanolic extract of *I. batatas* (**Figure 1b**) also exhibited increasing inhibition with concentration, although at a slightly lower potency. The $IC_{50}$ value of the extract was calculated at 62.63 ppm, which still classifies the extract as having strong anti-inflammatory potential according to established classification thresholds (Minarti et al., 2021; Farida et al., 2018). The observed activity is likely attributed to the presence of bioactive compounds such as flavonoids and tannins, which have been previously reported to inhibit inflammatory mediators and stabilize proteins through antioxidant and anti-denaturation mechanisms (Setyowati et al., 2014; Pramiastuti & Murti, 2022).

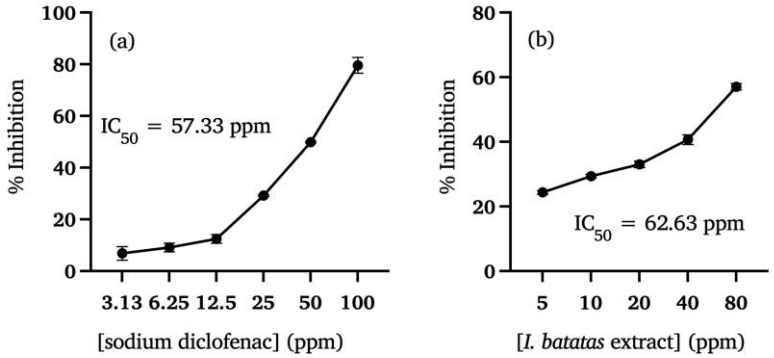


**Figure 1**. Relationship between concentration and inhibition percentage of protein denaturation and $IC_{50}$ values for (a) sodium diclofenac ($IC_{50}$ = 57.326 ppm) and (b) *I. batatas* ethanolic leaf extract ($IC_{50}$ = 62.628 ppm)

### 3.3. Granule and Tablet Evaluation

Following confirmation of anti-inflammatory activity, the ethanolic extract of *I. batatas* was formulated into tablets using various ratios of polyvinylpyrrolidone (PVP) and amylum manihot as binders. The resulting granules from all five formulations (F1–F5) were first assessed for flow properties to determine their suitability for direct compression.

Granule evaluation showed that all formulations possessed acceptable flow time, angle of repose, and compressibility index (**Figure 2**). Formulations F3 (PVP:amylum = 1:1) and F5 (PVP:amylum = 2:8) demonstrated the most favorable flow properties, with angle of repose values under 30° and compressibility indices below 20%, suggesting good granule flow and compressibility characteristics. These findings are consistent with previous studies stating that an angle of repose less than 40° and compressibility index below 20% reflect adequate flow behavior for tablet processing (Lachman et al., 1994; Siregar & Wikarsa, 2008).

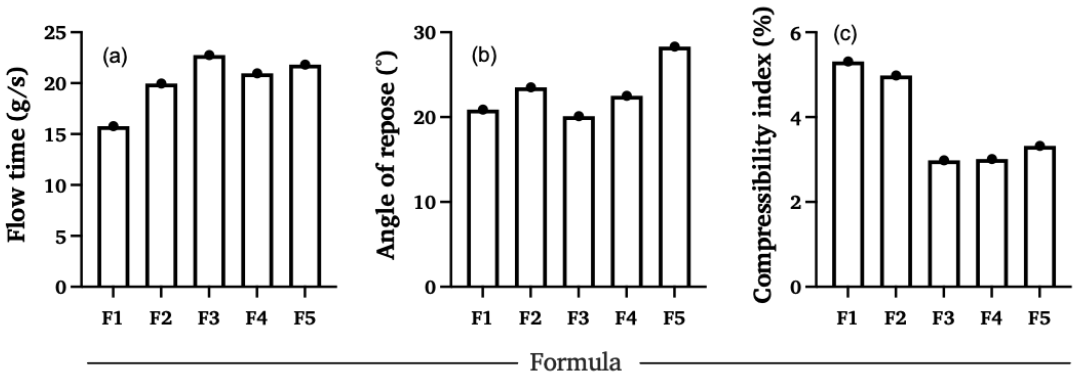


**Figure 2**. Evaluation of granule flow properties: flow time (a), angle of repose (b), and compressibility index (c) of different formulations (F1–F5)

Tablet evaluation included the evaluation of physical characteristics, including organoleptic properties, size uniformity, weight variation, hardness, friability, and disintegration time. Organoleptically, all formulations produced tablets that exhibited uniform color, shape, and odor characteristics. Measurements of diameter and thickness were consistent across batches and complied with pharmacopeial standards (Depkes RI, 1979; 2014). **Table 3** presents the measured average diameter and thickness for each formulation, showing minimal variation and confirming uniformity. **Figure 3** shows the tablets prepared using *I. batatas* leaves ethanol extract.

As shown in **Table 4**, all tablet formulations met the acceptable criteria for weight variation. However, notable differences were observed in mechanical strength and disintegration behavior. Formulation F3 demonstrated the most favorable performance, with a hardness of 5.77 ± 0.59 kg, friability of 0.75 ± 0.02%, and disintegration time of 6.02 ± 0.80 minutes. These values fall within the standard limits for uncoated herbal tablets, where hardness exceeds 4 kg, friability is less than 1%, and disintegration occurs within 15 minutes (Depkes RI, 2020).

**Figure 3.** Tablet of *I. batatas* leaves ethanol extract

Statistical analysis using one-way ANOVA followed by Tukey's HSD test revealed significant differences ($p < 0.05$) among formulations for hardness, friability, and disintegration time. Superscript letters in Table 4 indicate statistically significant groupings. F3 and F5 exhibited significantly greater hardness compared to F1 and F2, possibly due to synergistic binding interactions between PVP and amylum. F5 also showed the lowest friability, indicating improved mechanical stability, although its slightly prolonged disintegration time (6.25 ± 0.17 minutes) might affect onset of action.

**Table 3.** Size uniformity of *I. batatas* leaves ethanol extract tablet

| Size Uniformity | Formula | | | | |
|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 |
| Diameter average (cm) | 12.15 | 12.14 | 12.15 | 12.15 | 12.14 |
| Thickness average (cm) | 4.11 | 4.10 | 4.12 | 4.11 | 4.12 |

In contrast, formulations utilizing a single binder—F1 (PVP only) and F2 (amylum only)—displayed lower hardness and higher friability, confirming literature reports that combining synthetic and natural binders can enhance both mechanical properties and disintegration performance (Sari et al., 2021). Among all tested formulations, F3, with a 1:1 PVP-to-amylum ratio, was identified as the most balanced, offering a promising profile in terms of tablet strength and disintegration suitable for therapeutic application.

**Table 4**. Tukey HSD analysis of tablet mechanical properties and disintegration behavior

| Formula | Hardness (kg) | Friability (%) | Disintegration (min) | Weight (mg) |
|---|---|---|---|---|
| F1 | 3.47b | 1.09a | 2.69c | 508.1a |
| F2 | 3.77b | 0.98a | 4.66b | 506.6a |
| F3 | 5.77a | 0.75b | 6.02a | 507.8a |
| F4 | 3.67b | 0.86b | 3.07c | 507.7a |
| F5 | 5.65a | 0.43c | 6.25a | 508.6a |

Note: Values are expressed as mean ± SD ($n = 3$). Different letters within the same column indicate significant differences ($p < 0.05$) based on Tukey's HSD test.

## CONCLUSION

This study demonstrated that the ethanolic extract of purple sweet potato leaves (*Ipomoea batatas* (L.) Lam.) possesses strong anti-inflammatory activity, with an $IC_{50}$ value of 62.628 ppm, which is comparable to the standard anti-inflammatory agent, sodium diclofenac ($IC_{50}$ = 57.326 ppm). These findings indicate that the extract has considerable potential as a natural anti-inflammatory compound. The extract was successfully formulated into tablet dosage forms using various ratios of polyvinylpyrrolidone (PVP) and amylum as binders. Among the five formulations tested, the tablet prepared with a 1:1 ratio of PVP to amylum (Formulation F3) exhibited the most favorable physical characteristics, including appropriate hardness, low friability, and an acceptable disintegration time, all of which complied with established pharmacopeial standards for uncoated herbal tablets. The results suggest that combining synthetic and natural binders in balanced proportions improves tablet integrity while maintaining suitable disintegration behavior. Therefore, the ethanolic extract of *I. batatas* leaves is a promising candidate for further development as a standardized oral anti-inflammatory preparation, particularly when formulated with a 1:1 ratio of PVP and amylum binders.

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