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# Application Of Concentration And Kinds Of Solution Roots Of Water Hyacinth (*Eichhornia Crassipes*) To Increase The Seed Quality Performance Of Cowpea (*Vigna unguiculata ssp. cylindrica*)

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***Abstract:***
***Background**: Cowpea is cultivated on every continent except Antarctica. Over 80% of cowpea farmers in the developing countries use seeds of unknown quality status with reduced vigor. The decline in the physiological quality of the cowpea seeds decreased after 3 months of storage. Water hyacinth extract can be used as organic priming to improve the performance of seed quality. The purpose of this research was to study the effect of the kinds of water hyacinth root solution and determine the best concentration of each kind on seed quality performance.*
***Materials and Methods**: This research was carried out in May - November 2021 at the Plant Physiology Laboratory, University of Lambung Mangkurat, Indonesia. The experiment was arranged in a Completely Randomized Nested Design (concentrations nested in the kind of solution). Observations were made on seed germination, potential seed germination, vigor index, speed of germination, uniformity of seed germination, root length, plumule length, and dry weight of normal seedlings. Least Significant Different test was performed if the analysis of variance has a significant effect.*
***Results**: Results showed seeds germination, vigor index, speed of germination, plumule length, and dry weight of normal seedlings variables that received treatment with water hyacinth root solution were better than controls. There was no significant difference between treatment and control on the variables of seeds germination and germination potential.*
***Conclusion:** Water solvent ($k_1$) better than distilled water ($k_2$), and ($k_2$) better than powder dissolved in water ($k_3$). Tke concentrations of $c_1$ (7.5 % ) and $c_2$ (15.0 % ) in $k_1$ (water solvent) better than $c_3$ (22.5 %) and $c_4$ (30.0 %), the best concentration in $k_2$ was $c_1$, and for $k_3$ (powder dissolved in water) was different for variables that affected by concentration. Only $k_1c_2$ treatment was able to increase seed germination up to 80.67%.*
***Key Word**: water hyacinth root extract, cowpea, kind of solution, concentration, seed viability*

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## I. Introduction

Cowpea (*Vigna unguiculata* [L.] Walp.) is cultivated on every continent except Antarctica [1]. Cowpea in sub-Saharan Africa is a multipurpose [2]. In Indonesia, there are various local varieties of cowpea ie. from Maluku Province [3] and South Kalimantan [4]. Over 80% of cowpea farmers in developing countries use seeds that are of unknown quality status with reduced vigor [5]. The decline in the physiological quality of the cowpea seeds decreased after 3 months of storage [6].

Seeds priming with various materials were reported to be able to improve the performance of seed viability. Bio-priming with Plant Growth Promoting Regulation (PGPR) could be increased the viability of rice seeds[7], hydro-priming of cowpea seeds[8; 9; 10; 11; 12]. There is a positive effect of osmopriming with NaCl on cowpea seeds [8] and osmo-priming with Poly Ethylene Glycol (PEG) on cowpea seeds[9;10].

The use of organic priming to increase seed viability has been reported by several researchers, including 250 ppm seaweed extract in tomato seeds [13], water hyacinth root extract in cowpea nagara seeds[12;14] and longan seeds [15].

The roots of water hyacinth contain melatonin [16]. The physiological effect of exogenous melatonin on roots is the same as that of IAA which is an auxin group[17]. Water hyacinth filtrate has an effect like natural PGR on AB MIX media in hydroponic of *Ipomoea reptans*. P[18]. The complete amino acid in water hyacinth root can be used as a substitute for gibberellins [19].

The protein content of cowpea ranges from 11.21-34.91% and crude protein 3.94-22.12% [2]. Cowpea leaves were rich in beta-carotene in the ranges of 0.25–36.55 and iron 75.00 mg/100 g [20] and 0.89-65.21 mg beta-carotene / 100 g of dry weight [2]. The nutritional content of cowpeas depends on genokind [1].

The study of hydro-priming of cowpea seeds showed a positive effect on seeds viability [9]. Water hyacinth root extract 7.5% was the most efficient for seed germination, seed germination potential, and uniformity. Seed priming in 22.5% of the extract was most efficient for vigor index, seed growth speed, plumule length, and dry weight of normal seedling [12].

The kind of water hyacinth root extract also affects the viability of cowpea. In extracting an organic material, various solvents can be used, including ethanol, methanol, and water. The kind of solvent had a very significant effect on the yield of extraction, vitamin C, total flavonoids, and antioxidant activity of lemon rind[21]. Leaf, stem, and root extracts of water hyacinth extracted with distilled water had higher phenolic, flavonoid and tannin content than methanol solvent [22].

The solvent used of course affects the ease, cost, and time required. Therefore, it is necessary to study the concentration and kind of water hyacinth root solution, namely the extracted with water, extracted with distilled water, and powder of water hyacinth root dissolved in water. The purpose of this research was to study the effect of the kinds of water hyacinth root solution on the seeds viability of cowpea and to determine the best concentration of each kinds of water hyacinth root solution on seeds viability of cowpea.

## II. Material And Methods

The research was carried out in May - November 2021 at the Plant Physiology Laboratory, Faculty of Agriculture, University of Lambung Mangkurat, Indonesia. The materials used were cowpea seeds, water hyacinth root solution, namely a solution extracted with water, extracted with distilled water, and powder dissolved in water, test paper, distilled water, plastic, and rubber bands. The tools used were paper presses, basins, seeds soaking jars, ovens, scales, rulers, and tools for testing seed viability.

This research was arranged in a Nested Completely Randomized Design with separate control. The concentrations (7.5%, 15.0%, 22.5%, and 30.0%) were nested in the kinds of solution. The seeds used as experimental materials were soaked with 96% alcohol for 2 minutes. The immersion was intended to reduce the germination of the seeds from an average of 86.67% to 54.67%.

The required number of seeds and had been soaked in 96% alcohol for 2 minutes) were soaked in each kind of solution and each concentration for 9 hours. Separate control was carried out on un-soaked seeds. Seeds were sown according to the UKDdp method (test of rolled paper set up in plastic).

The observed variables were seed germination, potential germination, vigor index, germination seeds, uniformity of germination seeds, root and plumule length, and dry weight of normal seedling.

The data obtained were tested for homogeneity of variance with the Bartlett test. Analysis of Variance (Anova) were carried out following an additive linear model, namely:

Yijk = □ + KPij + €ijkl (i = 1, 2, 3,; j = 1, 2, 3, 4; k = 1, 2, 3)

Notes :

i = 1,2,3 (kind of solutions)

j = 1,2,3,4 (concentration nested in each kind)

k = 1,2,3 (replication)

Yijk = Observation result at experimental unit which received i level of kind, j level of concentration, and k level of replication.

μ = Mean of treatment

KPij = Treatment effect (consists of different effects of control vs. treatment, the effect of the kind of solution (K) at i level, and the effect of concentration (C) at j level on each kind

ε(ij)k = Effect of experimental error

If there was an effect of treatment based on analysis of variance, then the test was continued with the Least Significant Difference (LSD) Test at a significant level of 5%, as follows

$$LSD = t\alpha/2 \sqrt{MSE/r}$$

LSD = The value of least significant difference

tα /2 = t value

MSE = Mean Square of Error

r = replication

If the value of the difference in observations bigger than LSD, then there was a significant difference between the two values being compared.

## III. Result

Bartlet's test on all variables based on the original data showed a homogeneous variance, except for the vigor index (VI), but by transforming the data into square roots, the variance became homogeneous. The treatment had a very significant effect on the variables of vigor index (VI), speed of germination (SpG), uniformity of seeds germination (USG), plumule length (PL), and dry weight of normal seedlings (DWNS). The treatment had no significant effect on seed germination (SG), the potential of seeds germination (PSG), and root length (RL) at the level of 5%, but significantly affected seed germination at the level of 7.17%. The comparisons between control vs treatment had a very significant effect on the variables of VI, SpG, PL, and DWNS. The treatment had no significant effect on SG, PSG, USG, and RL, but it did affect the seed germination variable at the level of 5.57% (Table 1).

**Table 1.** The results of analysis variance of variables observed on cowpea (Vigna unguiculata ssp. cylindrical)

| SV | SG (%) | PSG (%) | SQR of VI (%) | SpG (% etmal) | USG (%) | RL (cm) | PL (cm) | DWNS (g) |
|---|---|---|---|---|---|---|---|---|
| T | 2.00# | 1.56 | 3.94** | 7.98** | 4.23** | 1.26 | 10.81** | 7.20** |
| *C* vs T | 4.08$ | 0.86 | 9.25** | 39.29** | 1.84 | 0.20 | 111.39** | 23.02** |
| K | 6.87** | 6.34** | 10.06** | 19.60** | 2.30 | 0.49 | 0.27 | 9.73** |
| C \| K | 0.69 | 0.56 | 1.99# | 1.91# | 4.93** | 1.49 | 1.93# | 4.88** |
| C\|$k_1$ | 0.68 | 0.93 | 1.76 | 1.24 | 5.02** | 0.26 | 1.72 | 9.43** |
| C\|$k_2$ | 0.27 | 0.66 | 0.87 | 1.08 | 3.21* | 1.53 | 3.19* | 2.42# |
| C\|$k_3$ | 1.11 | 0.10 | 3.33* | 3.42* | 6. 55** | 2.69 | 0.88 | 2.79$ |

Notes : SV = source of variances; T = treatment; *C* = control; K = kind, C = concentration; SG = seed germination; PSG = potential of seed germination; SQR of VI = square root of vigour index; SpG= speed of germination, USG = uniformity of seed germination; RL = root length; PL = plumule length ; DWNS = dry weight of normal seedling ; * = significant on the level of . 5%; ** = significant on 1%; # on SG = significant on 7.17%; $ on SG = significant on 5.57%; # on VI = significant on 8.64 %; # on SG = significant on 9.56%; # on PL = significant on 9.39%; # on DWNS = significant on 9.17 %; $ on DWNS = significant on6.39%

The factor of the kinds (K) had a very significant effect on all variables, except on the USG, PL, and RL which were not significant. Concentration on the kind of solution (C | K) had a very significant effect on USG and DWNS, had a significant effect on VI, SpG, and PL respectively at the level of 8.64 %, 9. 56 %, and 9.39 %, but had no significant effect (>10.00%) on the GS, PSG, and RL.

The concentrations in $k_1$ (water solvent) had a very significant effect on the USG and DWNS, a significant effect on USG and PL, a significant effect on DWNS at the level of 9.17 %, in $k_2$ (aquadest solvent), significant effect on USG and PL, and significant effect at the level of 9.17 % on the DWNS, in $k_3$ (powder dissolved in water), significant effect on VI and SpG, has a very significant effect on USG, and significant effect at the level of 6.39% on the DWNS.

**Comparison between Application of Water Hyacinth Root Extract and Control on Cowpea Seed Viability**

The results of the LSD test for each variable can be seen in Table 2. Priming of cowpea seeds with water hyacinth root extract had a positive effect on seed germination (mean treatment was 66.44% and control 48.00 %), VI (7.25% and 4.62 %), SpG (17.07 % and 4.69 %), PL (12.68 cm and 2.07 cm), and DWNS (1.05 g and 0.44.g).

Based on the comparison with the control, it can be seen that all concentrations at $k_1$ (73.33% - 80.67 %) had better SG values than control (48.00 %), except for $k_1|c_4$, (63.33%). All concentration levels in $k_2$ (aquadest solvent) had higher SG values (69.33 % - 79.33 %) than control. All concentrations in $k_3$ (powder dissolved in aquadest), with a range of 45.33 % - 64.67 %) were not significantly different from the control. The priming treatment of nagara cowpea seeds with water hyacinth root extract had a positive effect on VI (mean treatment was 6.27% and control was 4.62% - 7.25 % significantly different from the control (4.62%), except for $k_3|c_3$ with a VI value of 4.14%.

**Table 2.** Mean of control and treatment on variables observed on cowpea (*Vigna unguiculata* ssp. *cylindrical*)

| Code | Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SG (%) | PSG (%) | VI (%) | SpG (% etmal) | USG (%) | RL (cm) | PL (cm) | DWNS (g) |
| C | 48.00a | 80.00 | **4.62a** | **4.69a** | **20.67** | **11.54** | **2.07a** | **0.44a** |
| T | 66.44b | 74.72 | **6.27b** | **11.77b** | **25.78** | **11.94** | **11.27b** | **0.79b** |
| $k_1\|c_1$ | 73.33b | 82.00 | **6.36b** | **11.56b** | **15.33** | **11.77** | **11.64b** | **0.65b** |
| $k_1\|c_2$ | 80.67b | 85.33 | **6.71b** | **11.17b** | **29.33** | **11.77** | **10.18b** | **0.97b** |
| $k_1\|c_3$ | 75.33b | 83.33 | **7.25b** | **10.40b** | **30.67** | **11.91** | **10.73b** | **0.92b** |
| $k_1\|c_4$ | 63.33a | 73.33 | **5.59b** | **8.83b** | **16.67** | **10.94** | **12.68b** | **0.52a** |
| $k_2\|c_1$ | 73.33b | 79.33 | **7.20b** | **11.01b** | **34.00** | **12.66** | **12.68b** | **0.82b** |
| $k_2\|c_2$ | 79.33b | 79.33 | **7.25b** | **11.28b** | **23.33** | **12.35** | **9.39b** | **0.56b** |
| $k_2\|c_3$ | 69.33b | 74.67 | **6.25b** | **10.01b** | **18.67** | **10.30** | **11.70b** | **0.67b** |
| $k_2\|c_4$ | 70.00b | 70.00 | **7.20b** | **8.79b** | **27.33** | **12.26** | **12.41b** | **0.71b** |
| $k_3\|c_1$ | 64.67a | 69.33 | **6.43b** | **13.55b** | **28.67** | **12.94** | **11.65b** | **0.88b** |
| $k_3\|c_2$ | 56.67a | 68.00 | **5.64b** | **12.45b** | **34.67** | **12.46** | **10.34b** | **1.05b** |
| $k_3\|c_3$ | 45.33a | 65.33 | **4.14a** | **17.07b** | **15.33** | **10.33** | **10.19b** | **0.76b** |
| $k_3\|c_4$ | 46.00a | 66.67 | **5.22b** | **15.08b** | **35.33** | **13.61** | **11.59b** | **0.92b** |

Notes : Comparisons were only made with control; the letter behind the number (No. 2 to 14) which are different from the letter behind of control (the number 1) in the same column show that they are not significantly different from control (C) based on the LSD test at the 5% level; SG = seed germination; PSG = potential of seed germination; VI = vigour index; SpG= speed of germination, USG = uniformity of seed germination; RL = root length; PL = plumule length ; DWNS = dry weight of normal seedling

All concentrations in each kind of solution gave a better effect than control on the SpG and PL variables, SpG with a range of values (8.79% - 17.07%) and control (4.69%), while PL with a range of 9.39 cm - 12.68 cm and control 2.07 cm. Based on the comparison with the control, it can be seen that all concentrations in each kind of solution (0.65 g -1.05 g) had DWNS values better than the control (0.44 g), except for $k_1|c_4$, (0.52 g). Treatment and control had no significant effect on PSG, USG, and RL. each shows a value of 65.33 % - 85.33 %, 15.33 % - 35.33 %, and 10.33 cm - 12.94 cm.

**Effect of Water Hyacinth Root Extract Kind on Viability of Nagara Cowpea Seed**

The effect of kind of solution on the observed variables is presented in Table 3. The kind of solution has a significant effect on the variables of seed germination, PSG, SpG, and DWNS.

The kind of water solvent ($k_1$) has an SG value of 81.00% which is not significantly different from that of aquadest solvent ($k_2$), which is 75.83%. There is no significant difference between $j_2$ and $k_3$ (powder dissolved in water), 75.83% and 67.33%, respectively, but there is a significant difference between aquades solvent (81.00%) and powder (67.33%).

**Table 3.** Mean of kind of solutions on variables observed on nagara cowpea (*Vigna unguiculata* ssp. *cylindrical*)

| Code | Variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SG (%) | PSG (%) | VI (%) | SpG (% etmal) | USG (%) | RL (cm) | PL (cm) | DWNS (g) |
| $k_1$ | **73.17b** | **81.00b** | 6.48b | 10.49a | 23.00a | **11.60** | **11.31** | **0.76ab** |
| $k_2$ | **73.00b** | **75.83ab** | 6.98b | 10.27a | 25.83a | **11.89** | **11.54** | **0.69a** |
| $k_3$ | **53.17a** | **67.33a** | 5.30a | 14.54b | 28.50b | **12.33** | **10.95** | **0.90b** |

Notes : in the same column show that they are not significantly different from control (C) based on the LSD test at the 5% level; SG = seed germination; PSG = potential of seed germination; VI = vigour index; SpG= speed of germination, USG = uniformity of seed germination; RL = root length; PL = plumule length ; DWNS = dry weight of normal seedling

The kinds of solutions with water ($k_1$) and aquades ($k_2$) were not significantly different from each other in VI, SpG, and USG. For variable VI, both solutions were better (6.48% and 6.98%) than the powder dissolved in distilled water ($k_3$), which was 5.30%. The opposite happened to the SpG variable with values of 10.49% ($k_1$) and 10.27 % ($k_2$), which were lower in value compared to powder dissolved in water, which was 14.54% ($k_3$). Seed USG showed the same response as the SpG variable, namely 23.00 % ($k_1$) and 25.83% ($k_2$), which was lower than $k_3$, which was 28.50 %. There was no significant difference between kind of solution in the RL and PL variables. The DWNS variable at k1 has a value of 0.76 g which is not significantly different from $k_2$ (0.69 g) and k3 (0.9 g), but there is a significant difference between $k_1$ and $k_2$.

**Effect of Concentration in Each Kind of Water Hyacinth Root Extract on Viability of Cowpea Seed**

There was no effect of concentration on each kind of water hyacinth root extract solution on seed germination, seed germination potential, and root length (Table 4). Table 4 shows the effect of concentration in water solvent k1|C on ultrasound. Increasing the concentration of water hyacinth root extract from 7.50% to 15.0% increased USG from 15.33% to 29.33%. Increasing the concentration of water hyacinth root extract to 22.50% did not significantly increase the USG value (30.67%), even if it was increased to a concentration of 30.67% causing the USG value to decrease to 16.67%. The same thing happened to the dry weight of normal sprouts. Increasing the concentration of water hyacinth root extract from 7.50 % to 15.0% increased DWNS from 0.65 g to 0.97 g. Increasing the concentration of water hyacinth root extract to 22.50% did not significantly increase the DWNS value (0.92 g), even if it was increased to a concentration of 30.67%, the DWNS value decreased to 0.52 g).

**Table 4.** Effect of concentration in kinds extract of water hyacinth on variables were observed

| Concentration | Seeds Germination (%) | | | Potential of Seeds Germination (%) | | |
|---|---|---|---|---|---|---|
| | **$k_1$**\|C | $k_2$\|C | $k_3$\|C | **$k_1$**\|C | $k_2$\|C | $k_3$\|C |
| $c_1$ | **73.33** | **73.33** | **64.67** | 82.00 | 79.33 | **69.33** |
| $c_2$ | **80.67** | 79.33 | **56.67** | 85.33 | 79.33 | **68.00** |
| $c_3$ | **75.33** | 9.33 | **45.33** | 83.33 | 74.67 | **65.33** |
| $c_4$ | **63.33** | 70.00 | **46.00** | 73.33 | 70.00 | **66.67** |
| Concentration | Vigour Index (%) | | | Speed of Germination (% etmal) | | |
| | **$k_1$**\|C | $k_2$\|C | $k_3$\|C | **$k_1$**\|C | $k_2$\|C | $k_3$\|C |
| $c_1$ | **6.36** | **7.20** | **6.43c** | **11.56** | **11.01** | **13.55ab** |
| $c_2$ | **6.71** | **7.25** | **5.64bc** | **11.17** | **11.28** | **12.45a** |
| $c_3$ | **7.25** | **6.25** | **4.14a** | **10.40** | **10.01** | **17.07c** |
| $c_4$ | **5.59** | **7.20** | **5.22bc** | **8.83** | **8.79** | **15.08bc** |
| Concentration | Uniformitiy of Seeds Germination (%) | | | Root Length (cm) | | |
| | **$k_1$**\|C | $k_2$\|C | $k_3$\|C | **$k_1$**\|C | $k_2$\|C | $k_3$\|C |
| $c_1$ | **15.33a** | **34.00b** | **28.67b** | **11.77** | **12.66** | **12.94** |
| $c_2$ | **29.33b** | **23.33a** | **34.67bc** | **11.77** | **12.35** | **12.46** |
| $c_3$ | **30.67b** | **18.67a** | **15.33a** | **11.91** | **10.30** | **10.33** |
| $c_4$ | **16.67a** | **27.33ab** | 35.33c | **10.94** | **12.26** | **13.61** |
| Concentration | Plumule Length (cm) | | | Dry Weight of Normal Seedlings (g) | | |
| | **$k_1$**\|C | $k_2$\|C | $k_3$\|C | **$k_1$**\|C | $k_2$\|C | $k_3$\|C |
| $c_1$ | **11.64** | **12.68b** | **11.65** | **0.65a** | **0.82b** | **0.88a** |
| $c_2$ | **10.18** | **9.39a** | **10.34** | **0.97b** | **0.56a** | **1.05b** |
| $c_3$ | **10.73** | **11.70b** | **10.19** | **0.92b** | **0.67a** | **0.76a** |
| $c_4$ | **12.68** | **12.41b** | **11.59** | **0.52a** | **0.71ab** | **0.92b** |

Notes : the same letter behind the numbers in the same column in each variable shows no significant difference based on the least significant difference (LSD) test at a significance level of 5.%

The concentration of water hyacinth root extract with distilled water ($k_2$|C) as solvent had a significant effect on USG, LP, and DWNS. The highest value on ultrasound was at a concentration of 7.50% with a value of 12. 68%, on the length of the plumule it was 7.5. % (12.68%) although not significantly different from the concentration of 22.5. % (11.70 %) and 30.0. % (12.41.%), but significantly different from the concentration of 15. % (12.41. %). The highest DWNS value was indicated by a concentration of 7.50% with a value of 0.82 g. This value was higher than the concentrations of 15.00 % (0.56 g) and 22.5.% (0.67 g), but not significantly different from the concentration of 30.0% (0.71 g). There was no difference in DWNS in the treatment of water hyacinth root extract with distilled water at concentrations of 15.0%, 22.5%, and 30.0%.

The concentration of water hyacinth root powder dissolved in water ($k_3$|C) significantly affected VI, SG, USG, DWNS. The highest VI value was indicated by a concentration of 7.50 % with a value of 6.43%. This value is only significantly different from VI at a concentration of 22.5% (4.14%). The highest SG was found at a concentration of 22.5% (17.07%) which was not significantly different from 30.0% (15.08%), but significantly different from 7.5% (13.55%) and 15.0% (12.45%). The highest USG value was at a concentration of 30.0.% (35.33.%) and was not significantly different from a concentration of 15.0.0% (34.67.%). The highest DWNS value was indicated by a concentration of 15.0% with a value of 1.05 g. This value was higher than the concentrations of 15.00 % (0.56 g) and 22.5.% (0.67 g), but not significantly different from the concentration of 30.0% (0.71 g).

## IV. Discussion

### Water Hyacinth Root Extract Treatment vs Control

There were differences between the application of water hyacinth root extract compared to control on five variables, seed germination (SG), vigor index (VI), seed growth speed (SpG), plumule length (PL), and dry weight of normal germination (DWNS). On the other hand, potential seed germination, uniformity seed germination (USG), and root length. Thus it can be stated that the application of water hyacinth root extract for seed priming can increase seed viability compared to control.

The results showed that water hyacinth root extract could increase seed germination, but could not improve seed germination potential. This is because the potential for seed germination is a variable that is assessed based on the basic ability of the seed (potential). Seed germination potential is the maximum value of a seed's ability to germinate. Potential will only appear if the environmental conditions are favorable (supportive/optimal) for seed germination. Optimal condition support with the use of water hyacinth root extract was indicated by the seed germination variable. Seed germination is the ability of seeds to germinate normally under optimal conditions. This means that application of water hyacinth root extract can increase the value of seed germination compared to control.

The results of this study are in line with the research which states that the advantages of seed priming on various agricultural crops include faster sprouting time, more uniform appearance of sprouts, reduced embroidery, and plants grow more vigor[23].

The increase in seed viability due to the application of water hyacinth root extract is thought to be caused by the presence of compounds that can replace natural compounds that induce seed germination, there are various amino acids in water hyacinth, including tryptophan and methionine which are precursors for the formation of the growth hormone auxin, gibberellin, and cytokinin [24]. The hormones abscisic acid and gibberellins play a major role in regulating early germination [25].

Seed germination process begins with imbibition and followed by disgetion. The initial phase of seed germination includes imbibition followed by a plateau phase of water absorption when metabolism is reactivated. It was stated that the physiological condition of the seed was partially determined by the mRNA which was translated for the sake of imbibition. Transcription is influenced by ambient temperature, light conditions, and plant hormones, namely abscisic acid and gibberellins. Water imbibition at the beginning of the germination phase of *Arabidopsis thaliana* peaked when the testa ruptured and the end of the germination phase was when the endosperm ruptured. The early phase of seed germination is characterized by dynamic biomechanical changes along with very early changes in transcription of mRNA, protein, and hormone levels that regulate subsequent processes [25].

In the process of seed germination, gibberellins stimulate the formation of the enzyme -amylase [26] In line with that, a supernatant called deproteinised juice (DPJ) from the taro plant (*Colocasia esculenta* L) is a source of GA3 which can induce amylase activity [27].

The enzyme α-amylase functions to break down starch into simple sugars. Hydrolysis of starch in cells requires water from outside the cell so that the cell enlarges. The sugar produced from the hydrolysis of starch is used for cellular respiration in the mitochondria. The respiration process produces an energy source (ATP) for sprout growth [26].

Many researchers reported the positive effect of gibberellins on seed germination. GA3 accelerates the process of seed germination and the emergence of sprouts so that the sprouts become taller [28]. The positive effect of GA depends on the concentration, type of seed, age of seed, and duration of soaking. GA3 improved sprout growth. GA treatment on aging wheat seeds had a positive effect on seed germination and seedling growth [29]. Priming with GA improves germination index, germination quality, and germination resistance to oxidative stress. Priming of seeds affects the stimulation of metabolism in wheat germ, accelerates germination, and improves germination quality [30].

GA can be found in materials that can be used as organic priming in invigorating seeds. Deproteinised juice (DPJ) from taro plant (*Colocasia esculenta* L) was a better source of GA3 for cowpea germination compared to no treatment or synthetic GA3 treatment at a concentration of 10 ppm [27].

Immersion of seeds in natural PGR had a significant effect on viability and vigor of expired *Pagoda mustard* seeds [31]. The concentration of 50% coconut water had a better effect on the speed of germination of shallots compared to soaking in distilled water [32]. There was an interaction effect between natural PGR and the immersion time of F1 hybrid watermelon seeds on the variables of seed germination and root length. Seed germination at 14 DAP and the highest root length occurred in the shallot extract treatment with a soaking time of 7 hours [33]. The application of natural PGR of onion extract, bean sprout extract, and young coconut water could stimulate the germination of freshly harvested chili seeds, but not on expired seeds. However, chemical PGR containing gibberellins at a concentration of 200 ppm increased germination better than natural PGRs from onion extract, bean sprout extract, and coconut water [34].

The positive effect of water hyacinth root extract treatment in increasing the viability of seeds in this study was thought to be related to the natural PGR content in water hyacinth root extract which was able to improve seed germination. The presence of various amino acids in water hyacinth, including tryptophan and methionine which are precursors for the formation of growth hormone auxin, gibberellin, and cytokinins [24]. Water hyacinth root (*E. crassipes*), has a shikimic acid content of 0.05% -0.90% w/v [35]. Shikimic acid is a natural organic compound in the form of a shikimic anion which is an intermediate in the biosynthesis of the amino acid phenylalanine, tyrosine and tryptophan in plants and microorganisms [36].

Water hyacinth has a protein content of 12-18% and an amino acid content that can be useful as a gibberellin phytohormone [37]. The content of GA is also found in the root fiber of the ginseng plant. There are differences in GA content in different plant parts. Among the 7 parts of the ginseng plant observed, leaf peduncle, rhizome, and root fiber showed the highest gibberellins content in ginseng plants [38]. As in the ginseng plant, the parts of the water hyacinth are thought to have different ZPT content.

The use of water hyacinth root extract at a concentration of 75 g $L^{-1}$ has an effect on crop yields, and can reduce the number of seeds per cayenne pepper [39]. This strengthens the presence of GA in water hyacinth root extract, especially in relation to the function of GA which can interfere with seed formation. An indication of the presence of GA in water hyacinth root extract was also reported that spraying water hyacinth root extract on cayenne pepper could reduce the number of cayenne pepper seeds [40]. The best concentration obtained in this study was 225 g $L^{-1}$. Soaking eggplant seeds with organic water hyacinth fertilizer was better than the control and immersion in water, including the variables of seed germination in nurseries [41].

**Effect of Water Hyacinth Root Extract Solution on Viability of Cowpea Seed**

The kind of extract solution (water solvent, distilled water, and powder dissolved in distilled water) had a significant effect on six variables, namely seed germination (SG), seed germination potential (GP), vigor index (VI), seed growth speed (SpG), simultaneously seed growth (USG), and dry weight of normal germination (DWNS) but had no significant effect on two variables, namely root length (RL) and plumule length (PL). The difference in response to the kind of solvent was thought to be caused by differences in the composition of the extract and the resulting yield. The difference in yield produced certainly affects the amount of natural PGR and other compounds produced.

There was a significant difference in the yield of tiwai onion extract, namely 8.75% with water solvent, 5.30% ethanol solvent, and 8.31% with water and ethanol solvent. 8.31%. However, the three solvents produce the same chemical compounds, namely alkaloids, flavonoids, tannins, carbohydrates and steroids [42]. The difference in the extraction method used affects the total flavonoid content in the extract and fraction of Srigading leaves [43]. The use of methanol as a solvent in the noni fruit extraction process provides the best response to reduce the percentage of rumen protozoa viability and total gas production in vitro [44]. Meanwhile, water solvent is better than 70% ethanol solvent in Gracilaria seaweed extraction [45]. The yield of phycocyanin microcapsules of *Spirulina platensis* using a phosphate buffer extraction solvent of pH 7.0 was higher than the yield of phycocyanin microcapsules extracted with distilled water [46]. There is an effect of extraction method on antioxidant activity of 70% ethanol extract of guava leaves with white flesh [47]. The kind of solvent has a very significant effect on the yield, vitamin C, total flavonoids and antioxidant activity of lemon peel extract [21].

There is no significant difference between water solvent and distilled water solvent. Based on SG, PSG, and VI, it can be seen that water solvent is better than powder dissolved in distilled water. The SG and VI variables in distilled water were better than powders dissolved in water. Although the value of SpG and USG variables at $k_3$ was higher than $k_1$ and $k_2$, and DWNS was higher than $k_2$, the germination value in water and distilled water was 73.17% and 73.00%, respectively, while the powder dissolved in water was only 53.17%. Thus it can be stated that the best kind is water solvent, followed by distilled water, and powder dissolved in water. This is presumably because, the water solvent (well water) used in this study contains substances or compounds that are useful in induction of germination and early growth of seedlings, while distilled water is pure water that is free of minerals.

Aquades is mineral water that has been processed by distillation (distilled) to obtain pure water ($H_2O$) that is free of minerals [48; 49]. Methanol is a better solvent than water in extracting shikimic acid [35].

The use of distilled water in the manufacture of banana Barangan tissue culture media can be replaced with water that is not distilled water. The application of refilled drinking water and rainwater resulted in a higher plantlet height (6.75 and 6.37 cm) compared to distilled water (4.37 cm). While the PDAM treatment, clear well water, yellow well water, upstream river water, downstream river water, fish pond water showed a lower plantlet height than aquades. Furthermore, it was concluded that the growth media for banana Barangan seedling plantlets that were as good as aquades were rainwater, refilled drinking water, and clear well water. The advantage of unrefined water compared to distilled water (purified water) is the content of elements and compounds in it. The ammonium content in all studied water was higher than that of distilled water [50].

**Effect of Concentration on Each Kind**

Table 4 shows the positive effect of giving water hyacinth root extract, but too high a concentration can have a negative effect. This is thought to be caused by the effect of phytotoxins on plants.

Eggplant seeds at 1000 mg GA3 $L^{-1}$ had a phytotoxic effect that caused delays in seed germination and sprout formation, but at concentrations 750 mg GA3 $L^{-1}$ showed improvement in seedling height, speed of germination, and time of emergence of sprouts [28]. To maintain hormonal balance, plants can respond to GA with negative feedback, namely stimulating deactivation by inhibiting the expression of several genes associated with bioactive GA biosynthesis [51]. If the GA is excessive, it will be converted into a negative form, so that it has a negative effect on seed germination [52]. Invigoration of *Nephelium lappaceum* seeds in coconut water or 100 ppm GA solution tends to have a negative effect on seed viability during storage. up to 2 weeks compared to control [32].

In line with the use of GA, the best use of organic priming also occurs at certain concentrations. The application of sprout extract with a concentration of 100 g $L^{-1}$ resulted in a longer primary root length and a higher number of secondary roots compared to a concentration of 200 and 300 g $L^{-1}$ [53]. The sprout extract agronomically has the ability to increase *Mangosteen* seedling root growth compared to onion extract [41]. Based on the orthogonal polynomial on the roots of fig cuttings treated with onion extract, it can be stated that a concentration of 1.00% gave the best results on the growth of cutting roots, the number of roots at a concentration of 1.07%, while the maximum root length at a concentration of 1.14% [54].

The concentration of water hyacinth root extract at a concentration of 75 g $L^{-1}$ (7.5% w/v) can increase the height and yield and reduce the number of seeds of cayenne pepper compared to treatments of 0.0%, 2.5%, and 5.0% [39]. Water hyacinth leaf extract with a concentration of 25% resulted in the fastest germination of *P. roxb*urghii (14 days after seeding) and *B. purpurea* (11 days after seeding). The largest seedling diameter of *P. roxburghii* was obtained at a concentration of 75%, (1.52 mm). while in *B. purpurea* at a concentration of 25%, namely 1.34 mm [55].

The response of seeds to water hyacinth root extract treatment, among others, depended on the type of plant. Longan seeds showed a better response to germination percentage values, vigor index, and germination index to water hyacinth root extract concentration treatments than sapodilla and soursop seeds[15].

Solutions of water hyacinth plant powder 0%, 5%, and 10% were applied to wheat germ (*Triticum aestivum* L.), wild oats (*Avena fatua* L.), and “milk thistle” (*Silybum marianum* L). There was no significant difference in percent germination between treatments on wild oat seeds. The percentage of wheat seed germination at 10% was not significantly different from 5%, but lower than 0%. There was no significant difference between the concentrations of 0% and 5%. There was no difference in plumule length at all concentrations, both in wheat, wild oats, and milk thistle [56]. Water hyacinth leaf powder extract 0%, 2.5%, and 5% significantly decreased root length, plumule length, and weight of the roots of *Mimosa pig*ra and *Vigna radiata* sprouts, and weight of the plumule *Vigna radiate*. Furthermore, it was stated that there was bioherbicide activity in water hyacinth leaf powder extract which caused a decrease in the performance of *M. pigra* and *V. radiate* sprouts [57]. Referring to the growth requirements, although water solvent and aquadest were able to increase seed germination, there was only 1 treatment, namely $j_1c_2$ which was able to increase seed germination up to 80.67 %.

## V. Conclusion

Seeds germination, vigour index, speed of germination, plumule length, and dry weight of normal seedlings variables that received treatment with water hyacinth root solution were better than controls. There was no significant difference between treatment and control on the variables of seeds germination and germination potential. Water solvent ($k_1$) better than distilled water ($k_2$), and ($k_2$) better than powder dissolved in water ($k_3$). The concentrations of c1 (7.5 % ) and c2 (15.0 % ) in $k_1$ (water solvent) better than $c_3$ (22.5 %) and $c_4$ (30.0 % ), the best concentration in $k_2$ was $c_1$, and for $k_3$ (powder dissolved in water) was different for variables that affected by concentration. Only $k_1c_2$ treatment was able to increase seed germination up to 80.67%.

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