

From: **Biocatalysis and Agricultural Biotechnology** <em@editorialmanager.com>
Date: Thu, 1 Jul 2021, 21:58
Subject: Decision on submission to Biocatalysis and Agricultural Biotechnology
To: Maman Suryaman <msuryaman21@gmail.com>

Manuscript Number: BAB-D-21-00720

The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract

Dear Dr Suryaman,

Thank you for submitting your manuscript to Biocatalysis and Agricultural Biotechnology.

I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following major revision. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Aug 30, 2021.

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Biocatalysis and Agricultural Biotechnology values your contribution and I look forward to receiving your revised manuscript.

Kind regards,
Ching T. Hou
Editor-in-Chief

Biocatalysis and Agricultural Biotechnology

Editor and Reviewer comments:

Reviewer #1: Manuscript number: BAB-D-21-00720

Manuscript title: The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract

I think the study is quite interesting. However, there are some minor issues with the manuscript in this current state as below.

- 1) Highlights: Some of the highlights have exceeded the maximum allowable character (maximum 85 characters, including spaces, per bullet point).
- 2) Abstract: 'On the other hand' instead 'on the otherhand'. Try to combine the last two sentences together by factoring in the common effects.
- 3) Keywords: Capitalize the first keyword and use semicolon between the keywords
- 4) Introduction: Why mungbean? What is the significance of mungbean? Is it important for local consumption? Separate the mangosteen description into another paragraph. What is the significance of using mangosteen? Highlight the novelty in last paragraph.
- 5) Figures & Tables: Maybe put some figures to illustrate the difference?
- 6) Language: There are a number of language errors and incomplete sentences in the script. Please check the sentence structure, unit spacing, tenses and language carefully in the revised manuscript.
- 7) Have a look at the work of plant disease detection and biowaste for soil amendment.
<https://doi.org/10.1016/j.bios.2017.02.038>
<https://doi.org/10.1016/j.envpol.2020.115662>
- 8) Cite some recent and related works from Biocatalysis and Agricultural Biotechnology in revised version.

Reviewer #2: Manuscript Number: BAB-D-21-00720

Title: The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract.

Highlights and Figure Remarks:

- Good and interesting title, but it is suggested to keep the novelty of the study clearer in the title. Keep it within 15 words.
- It is suggested to only use single term word for keyword selection.
- Do not pick keywords from the title.
- Try adding abbreviation as too much of short form is used.
- It is preferred to have more points for highlights, that mentions the novelty of the paper.
- At the moment, highlight points does not follow the journal requirement. Keep it

within 85 character including space.

→ This topic can be a good review/research paper not a communication paper.

General Remarks:

Regretfully, my decision at this stage rejection. Significant effort is needed in revising this review paper. There are consistent grammar issues in the use of plural vs singular objects. This is to the point of being scientifically misleading. The writing of the communication needs to be further revise to fit well for Biocatalysis and Agricultural Biotechnology.

Specific Remarks:

→ Please revise the Abstract to underscore more specific outcomes of the review. Try to summarize the novelty and have the hypotheses achieved.

→ Keep the abstract within 200 words.

→ What is the purpose of making this paper a short communication?

→ DO NOT cite the references more than 5 years. There is a lot of reliability of concern on the information shared.

→ "2018 in the experimental garden of the Faculty of Agriculture, Siliwangi University, Tasikmalaya," This sentence is not required.

→ Why does the Mangosteen pericarp macerate for 3 days at room temperature?

→ Author mentioned "Mungbean plants were maintained to grow properly.". Do not be too general. What kind of maintenance was provided to allow grow well?

→ Poor presentation of results. There can be varies analysis that can be performed in justifying the study content on the hypothesis.

→ There is huge novelty gap in this manuscript. Please revise this study into a research paper not a short communication.

→ Avoid using terms such as "We", "I", "Our", in the write up. Keep the language more formal.

→ Write the conclusion in one paragraph (within 200 words).

→ The labelling of 'a','b' has to be superscript.

→ Reference bibliology is not as per journal formatting. Re-do the citations for entire manuscript.

→ Too many usages of "However, Moreover, Thus, in addition, On the other hand, try to re-phrase it.

→ There is too much copy paste of sentences from the body of the manuscript. Please check plagiarism before submission.

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From: **Ching T. Hou** <em@editorialmanager.com>

Date: Thu, 19 Aug 2021, 21:05

Subject: Decision on submission to Biocatalysis and Agricultural Biotechnology

To: "Maman Suryaman" <msuryaman21@gmail.com>,

CC: "Yaya Sunarya" yayasunarya@yahoo.ac.id, "Iis Istarimila" iis_istarimila@gmail.com, "Ahmad Fudholi" a.fudholi@gmail.com

Manuscript Number: BAB-D-21-00720R1

Effect of salinity stress on the growth and yield of mungbean (*Vigna radiata* (L.) R. Wilczek) treated with mangosteen pericarp extract

Dear Dr Suryaman,

Thank you for submitting your manuscript to Biocatalysis and Agricultural Biotechnology.

I am pleased to inform you that your manuscript has been accepted for publication.

My comments, and any reviewer comments, are below.

Your accepted manuscript will now be transferred to our production department. We will create a proof which you will be asked to check, and you will also be asked to complete a number of online forms required for publication. If we need additional information from you during the production process, we will contact you directly.

We appreciate you submitting your manuscript to Biocatalysis and Agricultural Biotechnology and hope you will consider us again for future submissions.

Kind regards,
Ching T. Hou
Editor-in-Chief

Biocatalysis and Agricultural Biotechnology

Editor and Reviewer comments:

Reviewer #1: Accept

Reviewer #2: The authors have responded all the questions and comments from the reviewer. Hence, I recommend to accept this paper for publication

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June 22, 2021

Professor Ching Hou, PhD.

Editors-in-Chief of Biocatalysis and Agricultural Biotechnology

Dear Professor,

I wish to submit a manuscript entitled “The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract” for possible consideration.

Finally I wish to affirm the manuscript has been prepared in accordance with instructions to authors. I also hereby affirm that the content of this manuscript or a major portion thereof has not been published in a refereed journal, and it is not being submitted for publication elsewhere.

Thank you very much and I shall wait for your kind response.

Best regards,

Maman Suryaman

Reviewers and/or Editors' comments and Author Respond

Ms. Ref. No.: BAB-D-21-00720

Title: The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract

Authors : Maman Suryaman, Yaya Sunarya, Iis Istarimila, Ahmad Fudholi

Date : August 8, 2021

Reviewers and/or Editors' comments:

Reviewers Comments	Author Respond and Revision
<p>Reviewer #1: Manuscript title: The effect of salinity stress on growth and yield of mungbean (<i>Vigna radiata</i> L.) treated with mangosteen pericarp extract</p> <p>I think the study is quite interesting. However, there are some minor issues with the manuscript in this current state as below.</p> <ol style="list-style-type: none"> 1) Highlights: Some of the highlights have exceeded the maximum allowable character (maximum 85 characters, including spaces, per bullet point). 2) Abstract: 'On the other hand' instead 'on the otherhand'. Try to combine the last two sentences together by factoring in the common effects. 3) Keywords: Capitalize the first keyword and use semicolon between the keywords 4) Introduction: Why mungbean? What is the significance of mungbean? Is it important for local consumption? Separate the mangosteen description into another paragraph. What is the significance of using mangosteen? Highlight the novelty in last paragraph. 5) Figures & Tables: Maybe put some figures to illustrate the difference? 6) Language: There are a number of language errors and incomplete sentences in the script. Please check the sentence structure, unit spacing, tenses and language carefully in the revised manuscript. 7) Have a look at the work of plant disease detection and biowaste for soil amendment. https://doi.org/10.1016/j.bios.2017.02.038 https://doi.org/10.1016/j.envpol.2020.115662 	<ol style="list-style-type: none"> 1) Highlights was revised with the maximum 85 characters, including spaces, per bullet point. 2) Abstract was revised with combine the last two sentences together by factoring in the common effects. 3) Keywords was revised with capitalize the first keyword and use semicolon between the keywords. 4) Introduction was revised. In page 3 (Line 58-74), explanation of why mungbean? What is the significance of mungbean? Is it important for local consumption? Separate the mangosteen description into another paragraph. What is the significance of using mangosteen? Highlight the novelty in last paragraph (See Line 73 and 74). 5) Done, add Figure 1 in manuscript. 6) The manuscript is thoroughly revised, and all possible grammatical error has been corrected with improved using professional proofread (kgsupport). 7) Done, 2 papers were cited from https://doi.org/10.1016/j.bios.2017.02.038

<p>8) Cite some recent and related works from Biocatalysis and Agricultural Biotechnology in revised version.</p>	<p>https://doi.org/10.1016/j.envpol.2020.115662 8) Done, as follow: Kumar, M., Kumar, R., Jain, V., and Jain, S., 2018. Differential behavior of the antioxidant system in response to salinity induced oxidative stress in salt-tolerant and salt-sensitive cultivars of Brassica juncea L. Biocatalysis and Agricultural Biotechnology. 13:12-19 Lotfi, R., Golezani, K.G., Pessarakli, M., 2020. Salicylic acid regulates photosynthetic electron transfer and stomatal conductance of mungbean (Vigna radiata, L.) under salinity stress. Biocatalysis and Agricultural Biotechnology. 26(2020):101635.</p>
<p>Reviewer #2 Reviewer #2: Manuscript Number: BAB-D-21-00720 Title: The effect of salinity stress on growth and yield of mungbean (Vigna radiata L.) treated with mangosteen pericarp extract.</p> <p>Highlights and Figure Remarks:</p> <ul style="list-style-type: none"> → Good and interesting title, but it is suggested to keep the novelty of the study clearer in the title. Keep it within 15 words. → It is suggested to only use single term word for keyword selection. → Do not pick keywords from the title. → Try adding abbreviation as too much of short form is used. → It is preferred to have more points for highlights, that mentions the novelty of the paper. → At the moment, highlight points does not follow the journal requirement. Keep it within 85 character including space. → This topic can be a good review/research paper not a communication paper. <p>General Remarks: Regretfully, my decision at this stage rejection. Significant effort is needed in revising this review paper. There are consistent grammar issues in the use of plural vs singular objects. This is to the point of being scientifically misleading. The writing of the communication needs to be further revise to fit well for Biocatalysis and Agricultural Biotechnology.</p> <p>Specific Remarks:</p> <ul style="list-style-type: none"> → Please revise the Abstract to underscore more specific outcomes of the review. Try to summarize the novelty and have the hypotheses achieved. → Keep the abstract within 200 words. → What is the purpose of making this paper a short communication? → DO NOT cite the references more than 5 	<ul style="list-style-type: none"> - Thank you, done. - Done, keyword was revised. - Done, keyword was revised. - Done, abbreviation was added. - Done, highlight was added. - Done, highlight was revised with Keep it within 85 character including space. - Thank you, done. This study is research paper (not a communication paper). <p>The manuscript is thoroughly revised, and all possible grammatical error has been corrected with improved using professional proofread (kgsupport) as shown in Appendix.</p> <ul style="list-style-type: none"> - Abstract was revised. - Done, The abstract is ~ 200 words. - Type of manuscript was revised. This manuscript is research paper (not a short communication paper).

<p>years. There is a lot of reliability of concern on the information shared.</p> <ul style="list-style-type: none"> → 2018 in the experimental garden of the Faculty of Agriculture, Siliwangi University, Tasikmalaya," This sentence is not required. → Why does the Mangosteen pericarp macerate for 3 days at room temperature? → Author mentioned "Mungbean plants were maintained to grow properly.". Do not be too general. What kind of maintenance was provided to allow grow well? → Poor presentation of results. There can be varies analysis that can be performed in justifying the study content on the hypothesis. → There is huge novelty gap in this manuscript. Please revise this study into a research paper not a short communication. → Avoid using terms such as "We", "I", "Our", in the write up. Keep the language more formal. → Write the conclusion in one paragraph (within 200 words). → The labelling of 'a','b' has to be superscript. → Reference bibliology is not as per journal formatting. Re-do the citations for entire manuscript. → Too many usages of "However, Moreover, Thus, in addition, On the other hand, try to re-phrase it. → There is too much copy paste of sentences from the body of the manuscript. Please check plagiarism before submission. 	<ul style="list-style-type: none"> - Done. - 2018 in the experimental garden of the Faculty of Agriculture, Siliwangi University, Tasikmalaya," This sentence was removed. - This sentence is omitted - Done, an explanation of the treatment in question is on lines 91-92. - Results was revised. - Done, type of manuscript was revised. This manuscript is research paper (not a short communication paper). - Done, the language more formal - Done, conclusion was revised with one paragraph (within 200 words). - Done, the labelling of 'a','b' has to be superscript. - References was revised. - The manuscript was revised. - The manuscript was revised, then similarity of this manuscript is only 12%.
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Acknowledgement

Authors also would like to thank the Reviewers and Editors due their appropriate and constructive suggestions as well as their proposed corrections, which have been utilized in improving the quality of this manuscript.

Highlights

- Mungbean treated with mangosteen pericarp extract was investigated under salinity stress.
- Increased salinity decreased the growth and yield of mungbean.
- Mangosteen pericarp extract increased the growth and yield of mungbean.
- Mangosteen pericarp extract mitigated mungbean yield loss under salinity stress.



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1 **Effect of salinity stress on the growth and yield of mungbean (*Vigna radiata* (L.) R.**
2 **Wilczek) treated with mangosteen pericarp extract**

3 Maman Suryaman^{1,*}, Yaya Sunarya¹, Iis Istarimila¹, Ahmad Fudholi^{2,3}

4
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13
14 **Abstract**

15 Salinity stress is one of the environmental factors that limit crop production. The objective was
16 to find out the effect of salinity stress on the growth and yield of mungbean (*Vigna radiata* (L.)
17 R. Wilczek) treated with mangosteen pericarp extract. A randomised block design arranged in
18 factorial pattern with two factors and three replications was used in the experiment. Salinity
19 stress consisted of three levels, namely, 0%, 0.5% and 1%, and mangosteen pericarp extract
20 consisted of two levels, namely, 0% and 1%. Plant height, leaf area, yield components and pod
21 yield were analysed by univariate variance and Duncan's multiple range test at 5% significance
22 level. The results showed that the increase in salinity stress reduced the leaf area, plant height,
23 yield components and yield of mungbean. However, the use of mangosteen pericarp extract
24 could increase the plant height, leaf area, yield components and yield of mungbean. The weight
25 reduction of 100 mungbean seeds at 1% salinity stress could be alleviated by the application of

26 1% mangosteen pericarp extract. Moreover, mangosteen pericarp extract could mitigate
27 mungbean yield loss caused by salinity stress.

28

29 **Keywords:** Agricultural, plants, fruit-trees, vegetative

30

31 **1. Introduction**

32 Agricultural land degradation in Indonesia negatively impacts the production of almost
33 all agricultural commodities, including mungbean. Mungbean is the third important legume in
34 Indonesia after soybean and peanut (Ministry of Agriculture Republic of Indonesia, 2018). It is
35 an important food and cash crop in the rice-based farming systems of South and Southeast Asia
36 (Nair and Schreinemachers, 2020). The harvest area of mungbean decreased from 229 thousand
37 hectares in 2015 to 198 thousand hectares in 2018, and its production also decreased from 271
38 thousand tons in 2015 to 235 thousand tons in 2018 (Ministry of Agriculture Republic of
39 Indonesia, 2018). Efforts have been made to increase mungbean production, including
40 intensification, extensification and increasing cropping intensity. Mungbean extensification is
41 directed to marginal lands, including saline lands, to avoid its competition with other important
42 commodities. Approximately 12.020 million hectares or 6.29% of the total land area of
43 Indonesia are prone to salinity (Karolinoerita and Yusuf, 2020).

44 Salinity is one of the main environmental factors that limit plant production (Zorb et
45 al., 2019). Salinity affects almost all the physiological and biochemical processes (Bistgani et
46 al., 2019), as well as morphological characteristics, of plants (Asghari and Ahmadvand, 2018).
47 Salinity stress affects almost all phases of the growth of leguminous plants, namely, the
48 germination, vegetative and reproductive phases (Mansouri and Kheloufi, 2017). Salinity stress
49 causes osmotic stress, nutrient imbalance, ion toxicity, increased reactive oxygen species (ROS)
50 production, decreased photosynthesis and reduced plant productivity (Kordrostami and Rabiei,

51 2019). The increase in ROS damages biomolecules, such as lipid, protein and DNA; changes
52 membrane integrity and ion transport; decreases enzyme activity; inhibits protein synthesis and
53 leads to cell death (Engwa, 2018; Soundararajan, 2019). Salinity-induced oxidative stress in the
54 form of ROS adversely affects plant growth and productivity (Kumar et al., 2018). Plants trigger
55 an antioxidant defence system through non-enzymatic compounds, such as ascorbic acid,
56 glutathione, α -tocopherol, carotenoids and flavonoids (Caparos, Hasanuzzaman, and Lao,
57 2019).

58 Mangosteen (*Garcinia mangostana* L.) is one of important fruit-trees in Indonesia. Total
59 production of Indonesian mangosteen in 2020 reached 322,414 ton (Badan Pusat Statistik,
60 2020), 60% of which (rind or pericarp) is discarded as waste (Cheok et al., 2018). The
61 biological waste threaten the environment, but actually, it can be used as organic fertilizer or
62 soil amendment (Chia et al., 2020). Lately, however, all the mangosteen parts, aril, pericarp and
63 other components are utilised (Kaur et al, 2020). The main bioactive compounds contained in
64 the skin and aril are xanthone derivatives (Murthy et al., 2018). Xanthone, a secondary
65 metabolite, has long been known as an antioxidant (Gondokesumo et al., 2019; Ibrahim et al.,
66 2016; Murthy et al., 2018). Xanthone is an anti-inflammatory, anti-allergic, anti-cancer, anti-
67 microbial, anti-parasitic and anti-bacterial agent (Ibrahim et al., 2016; Murthy et al., 2018). The
68 main component of mangosteen pericarp extract shows high antioxidant activity and
69 remarkably reduces oxidative damage to blood proteins because of its ability to neutralise ROS
70 (Suthammarak et al., 2016). Silva et al. (2016) also found that mangosteen pericarp extract is
71 effective as an antioxidant and protects DNA from free radical damage. Detection of DNA
72 using electrochemical biosensors have been developed to get fast and accurate information
73 about plant diseases (Low et al, 2017).

74 The study on the health benefits of mangosteen has been found elsewhere (Kaur et al,
75 2020). However, the effect of mangosteen pericarp extract on the performance of mungbean

76 plant under salinity stress condition has not yet been investigated. This study aimed to
77 determine the effect of salinity stress on the growth and yield of mungbean treated with
78 mangosteen pericarp extract. Novelty of this study is mangosteen pericarp extract mitigated
79 mungbean yield loss under salinity stress. Mangosteen pericarp extract increased the growth
80 and yield of mungbean.

81

82 **2. Material and methods**

83 The experiment was conducted from October to December in West Java, Indonesia at
84 an altitude of 350 metres above sea level. Mangosteen pericarp was washed thoroughly, dried
85 in the sun, blended, diluted in 1 L of methanol and stirred until the colour turned dark red. The
86 solution was then filtered, and the filtrate was evaporated at 60 °C until a thick extract was
87 obtained.

88 Mungbean seeds were soaked in 1% mangosteen pericarp extract and water (control)
89 for 12 h. The seeds were planted in polybags that contained an 8 kg mixture of soil and manure
90 (1:1, w/w). Salinity stress treatment was applied by pouring NaCl solution (1%, 0.5% and 0%
91 [control]) every other day from the one week to five weeks after planting. Mungbean plants
92 were maintained (the plants were given inorganic N, P, and K fertilizer, and were hand weeded).

93 The experiment used a randomised block design with a factorial pattern that is consisted
94 of two factors and four replications. The first factor was salinity level with three levels, namely,
95 0%, 0.05% and 1% NaCl. The second factor was the concentration of mangosteen pericarp
96 extract, which consisted of two levels, namely, 0% and 1%. The observed data were plant
97 height, leaf area, yield components and yield. The data were analysed using univariate ANOVA
98 and then Duncan's multiple range test at 5% significance level (Steel et al., 1997).

99

100

101 3. Results and discussion

102 The plants experienced salinity stress is indicated by the yellowing leaves. The degree of
 103 yellowish color of the leaves indicates the severity level of salinity stress (Figure 1). Table 1
 104 shows that based on ANOVA, salinity stress and mangosteen pericarp have an interaction effect
 105 extract on the weight of 100 mungbean seeds substantial independent effects on the growth and
 106 yield of mungbean plants.

107



108

109 Figure 1. Vegetative performance of mungbean

110

111 Table 1. ANOVA of plant height, leaf area, number of pod, number of seed per pod, pod
 112 weight and the weight of 100 dried mungbean seeds under salinity stress and treatment with
 113 mangosteen pericarp extract.

Parameter	Salinity stress	Mangosteen pericarp extract	S × M interaction	CV (%)
Plant height	117.51**	19.96*	0.37	7.22
Leaf area	21.43*	9.34*	2.26	16.47
Number of pod	26.16*	5.52*	3.25	3.67
Number of seed per pod	18.34*	0.40	0.27	4.97
Weight of pod	28.20*	9.98*	3.63	8.25
Weight of 100 seed	30.65*	1.0	4.41*	2.72

114 Note: * significant, ** highly significant (Steel et al., 1997).

115 Statistical data analysis indicated that salinity stress and mangosteen pericarp extract
 116 did not show a remarkable interaction effect on the plant height and leaf area of mungbean.
 117 Increased salinity to 0.5% and 1% remarkably reduced the plant height by 17.4% and 30.9%,
 118 respectively. Moreover, the leaf area was reduced by 22.5% under 1% NaCl concentration. By
 119 contrast, the use of mangosteen pericarp extract increased the plant height and leaf area by
 120 50.4% and 14.6%, respectively (Table 2). Increased salinity hampered the growth process
 121 because of the decrease in water absorption by plant roots and the increase in osmotic stress.
 122 Salinity affects plants through osmotic effects, ion toxicity and/or nutrient deficiencies (Ahmed
 123 et al., 2016). Salinity can reduce leaf photosynthetic activity by affecting stomatal and non-
 124 stomatal factors (Lotfi et al., 2020). It also affects the initial growth of plant, causes oxidative
 125 stress and reduces chlorophyll content (Kordrostami and Rabiei, 2019). Thus, salinity reduces
 126 plant height, leaf area and plant dry weight (Setiawati et al., 2018).

127

128 Table 2. Effect of salinity stress on plant height and leaf area of mungbean treated with
 129 mangosteen pericarp extract

Treatments	Plant height (cm)	Leaf area (cm ²)
0 % NaCl	57.5 ^a	1071 ^a
0.5 % NaCl	47.5 ^b	1176 ^a
1 % NaCl	39.7 ^c	830 ^b
0% mangosteen pericarp extract	46.1 ^b	956 ^b
1% mangosteen pericarp extract	50.4 ^a	1096 ^a

130 Note: Numbers marked with the same letter in the same column shows no significant difference
 131 according to Duncan's Multiple Ranges Test 5% significance level.

132

133 Xanthone derivatives, including α -mangostin, can scavenge free radicals, which disrupt
 134 or inhibit the growth process (Ibrahim et al., 2016), as indicated by the increase in plant height
 135 and leaf area. The increase in salinity stress from 0% to 1% decreased the number of pods, the

136 number of seeds and dry pod weight. In comparison, mangosteen pericarp extract increased the
 137 number of pods, number of seeds per pod and the dry pod weight (Table 3).

138

139 Table 3. Effect of salinity stress on number of pods, number of seeds per pod and dry weight
 140 of pod treated with mangosteen pericarp extract.

Treatments	Number of pod	Number of seed per pod	Weight of pod (g)
0 % NaCl	12.62 ^a	8.19 ^a	16.60 ^a
0.5 % NaCl	10.33 ^b	8.62 ^a	12.58 ^b
1 % NaCl	7.70 ^c	6.90 ^b	7.78 ^c
0% mangosteen pericarp extract	9.55 ^b	7.58 ^b	10.80 ^b
1% mangosteen pericarp extract	10.88 ^a	8.20 ^a	13.83 ^a

141 Note: Numbers marked with the same letter in the same column show no significant difference
 142 according to Duncan's multiple range test at 5% significance level.

143

144 Salinity stress reduced the number of pods, the number of seeds per pod and pod weight
 145 of by 39%, 16% and 53%, respectively, compared with those of control. The energy conversion
 146 to yield is reduced under stress conditions, because part of the energy is used for stress
 147 alleviation in addition to growth and maintenance (Munns and Gilliam, 2015; Zorb et al.,
 148 2019). Salinity stress reduces the photosynthesis rate and limits the allocation of photosynthate
 149 to the reproductive part (Farooq et al., 2015). The limitation of photosynthate translocation into
 150 sinks under salinity stress causes the failure of grain filling and reduces the number of seeds;
 151 thus, salinity stress hampers physicochemical processes during the grain filling stage (Razzaq
 152 et al., 2020). The decrease in assimilate content is due to the shortening of the grain filling stage
 153 as salinity stress causes early plant senescence (Prathap et al., 2019). Mangosteen pericarp
 154 extract remarkably increased the yield component and yield of mungbean. Mangosteen pericarp
 155 extract increased the number of pods, the number of seeds and pod weight by 14%, 8% and
 156 28%, respectively, compared with those of the control. The antioxidative properties of xanthone
 157 and flavonoid compounds contained in mangosteen pericarp are able to capture free radicals by
 158 transferring labile H atoms to radical oxygen species (Chew and Lim, 2018; Kaurinovic and
 159 Vastag, 2019).

160 Salinity stress caused a remarkable interaction effect with mangosteen pericarp extract
 161 on the weight of 100 dried mungbean seeds (Table 4). An increase in salinity stress from 0% to

162 1% was followed by the decrease in weight of 100 mungbean seeds with or without 1%
 163 mangosteen pericarp extract treatment. Mangosteen pericarp extract (1%) can prevent a
 164 decrease in the weight of 100 mungbean seeds under 1% salinity stress condition. Salinity stress
 165 increased ROS production, which will further damage the cell membrane, reduce chlorophyll
 166 content and decrease the photosynthesis rate. However, mangosteen pericarp extract is able to
 167 neutralise ROS and suppress the damage (Farooq et al., 2015). The oxidative effect suffered by
 168 mungbean plant subjected to salinity stress was alleviated by xanthone and flavonoid
 169 compounds contained in the mangosteen pericarp extract.

170

171 Table 4. Effect of salinity stress on the weight of 100 mungbean seeds treated with
 172 mangosteen pericarp extract.

Salinity stress	Mangosteen pericarp extract	
	0 %	1 %
	------(g)-----	
NaCl 0 %	8.89 ^a A	8.94 ^a A
NaCl 0.5 %	8.10 ^b A	7.62 ^b A
NaCl 1%	6.94 ^c B	7.76 ^b A

173 Note: Numbers marked with lowercase letters in the same column and uppercase letters in the
 174 same line are not significantly different according to Duncan's multiple range test at 5%
 175 significance level.

176

177 4. Conclusion

178 Increased salinity stress reduced the leaf area, plant height, yield components and yield of
 179 mungbean. However, the use of mangosteen pericarp extract could increase the plant height,
 180 leaf area, yield components and yield of mungbean. The weight reduction of 100 mungbean
 181 seeds at 1% salinity stress could be alleviated by the application of 1% mangosteen pericarp
 182 extract. Mangosteen pericarp extract could mitigate mungbean yield loss under salinity stress.

183

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187

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301

302 **Abbreviation**

303 g: gram

304 M: Mangosteen

305 S: Salinity

306 CV: Coefficient of Variation

307 DNA: Deoxyribonucleic Acid

308 ROS: Reactive Oxygen Species

Declaration of interests

Title of Manuscript:

The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract

Corresponding Author:

Maman Suryaman

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

June 22, 2021

Professor Ching Hou, PhD.

Editors-in-Chief of Biocatalysis and Agricultural Biotechnology

Dear Professor,

I wish to submit a manuscript entitled “The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated with mangosteen pericarp extract” for possible consideration.

Finally I wish to affirm the manuscript has been prepared in accordance with instructions to authors. I also hereby affirm that the content of this manuscript or a major portion thereof has not been published in a refereed journal, and it is not being submitted for publication elsewhere.

Thank you very much and I shall wait for your kind response.

Best regards,

Maman Suryaman

Highlights

- The effect of salinity stress on the growth and yield of mungbean treated with mangosteen pericarp extract is investigated.
- A randomized block design with factorial pattern was used in the experiment consisted of two factors and three replications.
- The data, -plant height, leaf area, yield components and pod yield-, were analyzed by univariate variance and followed by Duncan's multiple range test.
- An interaction effect between salinity stress and mangosteen pericarp extract on the weight of 100 seeds.
- The increase in salinity stress reduced the leaf area, plant height, yield components, and pod yield.

1 **The effect of salinity stress on growth and yield of mungbean (*Vigna radiata* L.) treated**
2 **with mangosteen pericarp extract**

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12

13 **Abstract**

14 Salinity stress is one of the environmental factors that limits crop production. The objective was
15 to find out the effect of salinity stress on the growth and yield of mungbean treated with
16 mangosteen pericarp extract. A randomized block design with factorial pattern was used in the
17 experiment consisted of two factors and three replications. Salinity stress (NaCl concentration)
18 consisted of three levels, 0, 0.5, and 1%; and mangosteen pericarp extract consisted of two
19 levels, 0 and 1%. The data, -plant height, leaf area, yield components and pod yield-, were
20 analyzed by univariate variance and followed by Duncan's multiple range test at 5%. The
21 results showed that there was interaction effect between salinity stress and mangosteen pericarp
22 extract on the weight of 100 seeds. The increase in salinity stress reduced the leaf area, plant
23 height, yield components, and pod yield. On the otherhand, mangosteen pericarp extract
24 increased the plant height, leaf area, yield components, and pod yield.

25

26 **Keywords:** mangosteen pericarp extract, mungbean, salinity stress

27

28 **1. Introduction**

29 Agricultural land degradation in Indonesia gives impact to significant decrease in
30 production of almost all agricultural commodities includes mungbean. The harvest area of
31 mungbean decreased from 229 thousands hectares in 2015 to 207 thousands hectares in 2017,

32 and also its production decreased from 271 thousands tons in 2015 to 244 thousands tons in
33 2017 (Suwandi *et al.*, 2017). Efforts to increase mungbean production are through
34 intensification, extensification, and increasing cropping intensity (Rachman *et al.*, 2013). To
35 avoid its competition with others important commodities, extensification of mungbean is
36 directed to marginal lands, includes saline lands.

37 Salinity affects almost all physiological and biochemical processes (Roy dan Sengupta,
38 2014; Farooq *et al.*, 2015), as well as morphological characteristics of plants (Asghari dan
39 Ahmadvand, 2018). Salinity stress affects almost all phases of the growth of leguminous plants,
40 the germination, vegetative and reproductive phases (Mansouri dan Kheloufi, 2017). Salinity
41 stress causes osmotic stress, nutrient imbalance, ion toxicity, increases production of reactive
42 oxygen species (ROS), and decreases photosynthesis, and reduces plant productivity (Farooq *et*
43 *al.*, 2015). The increase of ROS causes biomoleculars, such as lipid, protein, and DNA
44 damages, change in membrane integrity and ion transport, decreases enzyme activity, inhibits
45 protein synthesis leads to cell death (Sharma *et al.*, 2012). The main bioactive compounds
46 contained in mangosteen (the skin and aryl) are xanthone derivatives (Murthy *et al.*, 2018). As
47 a secondary metabolite, xanthone has long been known as antioxidant (Kurniawati *et al.*, 2010;
48 Ngawhirunpat *et al.*, 2010; Tjahjani *et al.*, 2014; Murthy *et al.*, 2018), anti inflammatory, anti-
49 allergic, anti-cancer, anti-microbial, anti-parasitic, and anti-bacterial (Orozco dan Failla, 2013;
50 Ibrahim *et al.*, 2016; Murthy *et al.*, 2018). The main component of mangosteen pericarp extract
51 shows high antioxidant activity and significantly reduces oxidative damage to blood proteins,
52 and is thought to be due to its ability to neutralize ROS (Suthammarak *et al.*, 2016). Silva *et al.*
53 (2016) also found a similar research fact that mangosteen pericarp extract is effective as an
54 antioxidant and protects DNA from free radical damage. Thus, the use of mangosteen pericarp
55 extract can potentially be used to reduce the impact of damage due to salinity stress. This study

56 aimed to find out the effect of salinity stress on the growth and yield of mungbean treated with
57 mangosteen pericarp extract.

58

59 **2. Material and methods**

60 The experiment was conducted in October to December 2018 in the experimental garden
61 of the Faculty of Agriculture, Siliwangi University, Tasikmalaya, West Java at the altitude of
62 350 meters above sea level. The tools used were blender, evaporator, oven, analytical scales,
63 hygrometer, ruler, measuring cups, stationery. The materials used were NaCl, mungbean var.
64 Vima-1, mangosteen pericarp extract, manure, soil, and polybags. Mangosteen pericarp after it
65 was washed thoroughly, it was dried in the sun, and it was then blended and then was diluted
66 in 1 L methanol, stirred until the color turned dark red, and then macerated for 3 days at room
67 temperature. The solution was then filtered, and the filtrate was then evaporated at 60°C until a
68 thick extract was obtained.

69 Before being planted, mungbean seeds were soaked in 1% mangosteen pericarp extract
70 and water (as control treatments) for 12 hours. The seeds were then air dried, and then planted
71 in polybags contained a mixture of soil and manure. Mungbean plants were maintained to grow
72 properly. Started from the age of one week after planting, salinity stress treatment was applied
73 by pouring NaCl solution 1%, 0.5%, and 0% (control) every 2 days until the plants aged 5
74 weeks after planting.

75 The experiment used a randomized block design with factorial pattern consisted of two
76 factors and 4 replications. The first factor was salinity level (NaCl concentration) consisted of
77 three levels ie. 0, 0.05, and 1% NaCl. The second factor was concentration of mangosteen
78 pericarp extract consisted of two levels ie. 0 and 1%. The observed data were plant height, leaf
79 area, yield components, and pod yield. The data were analyzed by univariate variance continued
80 by Duncan's Multiple Range Test at 5% significant level (Steel & Torrie, 1993).

81 3. Results and discussion

82 Statistical data analysis indicated that the treatment of salinity stress did not show a
83 significant interaction effect with mangosteen pericarp extract on the plant height and leaf area.
84 The increased level of salinity stress significantly reduced the plant height and leaf area.
85 Conversely, the use of mangosteen pericarp extract affected the increase in plant height and leaf
86 area (Table 1). The increase in salinity stress reduces water absorption by plant roots due to the
87 increase of osmotic stress, so that the growth process is hampered. It is in accordance with
88 Ahmed *et al.* (2016) stating that salinity affects plants through osmotic effects, ion toxicity,
89 and/or nutrient deficiencies. Salinity also affects the initial growth of mungbean causes
90 oxidative stress and reduces chlorophyll content of leaf (Saha *et al.*, 2010), reduces plant height,
91 leaf area, and plant dry weight (Setiawati *et al.*, 2018).

92

93 Table 1. Effect of salinity stress on plant height and leaf area of mungbean treated with
94 mangosteen pericarp extract

Treatments	Plant height (cm)	Leaf area (cm ²)
0 % NaCl	57,5 c	1071 b
0,5 % NaCl	47, 5 b	1176 b
1 % NaCl	39,7 a	830 a
0% mangosteen pericarp extract	46,1 a	956 a
1% mangosteen pericarp extract	50,4 b	1096 b

95 Notes: Number marked with the same letter in the same column shows no significant
96 difference according to Duncan's Multiple Ranges Test 5% significance level.

97

98 Meanwhile, xanthone derivatives including α -mangostin contained in mangosteen
99 pericarp extract can act as free radical scavengers (Ibrahim *et al.*, 2016) which are produced
100 when cells are stressed, thus disruption or inhibition to the growth process due to free radicals
101 can be overcome so that the plant height and leaf area increased.

102 Based on the statistical analysis, it is shown that the treatment of salinity stress did not
103 cause a significant interaction effect with mangosteen pericarp extract on the number of pods,
104 number of seeds per pod, and dry weight.of pod. The increase in salinity stress from 0% to 1%
105 was followed by a significant decrease in the number of pods, number of seeds and the dry
106 weight of pods. Meanwhile, mangosteen pericarp extract increased the number of pods, number
107 of seeds per pod, and dry weight of pod (Table 2).

108

109 Table 2. Effect of salinity stress on number of pod, number of seed per pod, and dry weight
 110 of pod treated with mangosteen pericarp extract

Treatments	Number of pod	Number of seed per pod	Weight of pod (g)
0 % NaCl	12,62 c	8,19 b	16,60 c
0,5 % NaCl	10,33 b	8,62 b	12,58 b
1 % NaCl	7,70 a	6,90 a	7,78 a
0% mangosteen pericarp extract			
1% mangosteen pericarp extract	9,55 a	7,58 a	10,80 a
	10,88 b	8,20 b	13,83 b

111 Notes: Number marked with the same letter in the same column shows no significant
 112 difference according to Duncan's Multiple Ranges Test 5% significance level.

113

114 Salinity stress reduced the number of pods by 39%, and the number of seeds per pod
 115 reduced by 16%, and reduced the weight of pod by 53% compared to control treatment. Under
 116 stress conditions, in addition to using energy for growth and maintenance, plants also use energy
 117 for stress tolerance, so that energy conversion to yield is reduced (Munns and Gilliam, 2015;
 118 Zorb *et al.*, 2019). Salinity stress reduce the rate of photosynthesis and limit the allocation of
 119 photosynthate to the reproductive part (Farooq *et al.*, 2015). Limitation of photosynthate
 120 translocation into sinks is a major cause of failure to fill seeds and a reduction in the number of
 121 seeds under conditions of salinity stress (Hutsch *et al.*, 2014). On the other hand, the application
 122 of mangosteen pericarp extract significantly increases the yield component and the yield of
 123 mung bean pods. The application of mangosteen pericarp extract increased the number of pods
 124 by 14%, increased the number of seeds by 8% and increased pod weight by 28% compared to
 125 control. Mangosteen pericarp extract contains various bioactive compounds including phenolic
 126 compounds and flavonoids which can be used as a source of antioxidants (Suttirak and
 127 Manurakchinakorn, 2012). Antioxidative properties of xanthone and flavonoid compounds
 128 contained in mangosteen pericarp extract are related to the ability to capture free radicals by

129 transferring labile H atoms to radicals (Chew and Lim, 2018), so that the negative effects of
 130 free radicals can be mitigated.

131 Based on the statistical analysis it is shown that the treatment of salinity stress causes a
 132 significant interaction effect with mangosteen pericarp extract on the weight of 100 dried seeds
 133 (Table 3). An increase in salinity stress from 0% to 1% is followed by a decrease in weight of
 134 100 grains at all levels of mangosteen pericarp extract, but application of mangosteen pericarp
 135 extract 1% can prevent a decrease in weight of 100 grains under 1% salinity stress condition.
 136 Salinity stress increased ROS production which will further damage the cell membrane so that
 137 it reduce the amount of chlorophyll which results in a decrease in the rate of photosynthesis
 138 (Farooq *et al.*, 2015). It is suspected that by giving mangosteen pericarp extract which contains
 139 many antioxidants can neutralize ROS so that the radical damage can be suppressed.

140
 141 Table 3. Effect of salinity stress on weight of 100 seed treated with mangosteen pericarp extract

Salinity stress	Mangosteen pericarp extract	
	0 %	1 %
	------(g)-----	
Na Cl 0 %	8,89 c A	8,94 b A
Na Cl 0,5 %	8,10 b A	7,62 a A
Na Cl 1%	6,94 a A	7,76 a B

142 Note: Numbers marked with lowercase letters in the same vertical direction and uppercase
 143 letters in the same horizontal direction are not significantly different according to
 144 Duncan's Multiple Range Test at 5% significance level.

145
 146 **4. Conclusion**

147 As conclusion of this study as follow:

148

- 149 ▪ There was an interaction effect between salinity stress and mangosteen pericarp extract
150 on the weight of 100 seeds. The reduction in weight of 100 grains due to 1% salinity
151 stress treatment can be prevented by the application of 1% mangosteen pericarp extract.
152 ▪ Increasing the level of salinity stress reduces leaf area, plant height, yield components
153 and pod yield, on the other hand the use of mangosteen pericarp extract increases plant
154 height, leaf area, yield components and yield of mung bean pods.

155

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Declaration of interests

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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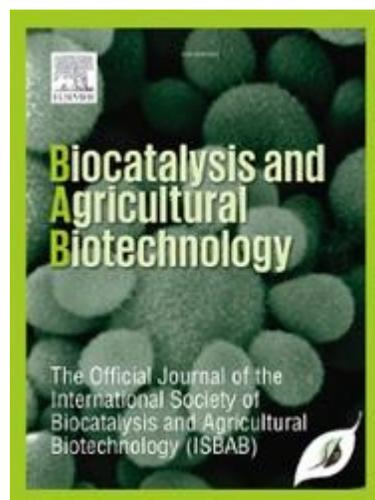
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