Original article:
The Effects Comparisons of *Sauropus androgynous*, *Moringa oleiefera* alone and in combination on iron deficiency in anemia rats
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Abstract
Background: Leaves extract of *Sauropus androgynous* (Sa) or *Moringa oleiefera* (Mo) alone has been shown to increase hemoglobin level in iron deficiency anemia. The combination of the two extracts have been known to potentially have a synergistic effect on anemia. The objective of this study is to compare the anti-anemic effect of Sa, Mo alone and their combination on iron deficiency anemia in rats. Methods: Thirty female wistar strain rats were randomly divided into 5 groups: normal, iron deficiency anemia, Sa, Mo and the combination of Sa and Mo. Beside the normal group, rats were fed Fe-deficient diet to induce iron-deficiency anemia. Level of hemoglobin, ferritin and plasma MDA were measured on day 8 (after induction of anemia) and day 29. Data were analyzed using One Way ANOVA followed by LSD post hoc test. Result: The rats fed with Fe-deficient diet for 7 days shown significantly had a lower plasma Hb and ferritin levels and higher plasma MDA levels compared to the normal group (p <0.05) After the treatment, the rats given the extracts significantly had a higher mean of Hb and Ferritin and a lower mean of MDA level compared to anemic control. The mean Hb, ferritin and MDA level of the combination group were close to normal group. Conclusion: The combination of the leaves extract of *Sauropus androgynous* or *Moringa oleiefera* is more effective against iron deficiency anemia compared to extract alone in rats.

Keyword: *Sauropus androgynous* extract; *Moringa oleiefera* extract; Combination extract; antianemia

Introduction
Anemia is still become health concern in Indonesia1-3. A study conducted by National Health survey (RISKESDAS) in 2013 showed that anemia in children under five years of age, pregnant women and the elderly in Indonesia were 28.1%; 37.1% and 44.2%, respectively4. The proportion of iron deficiency anemia in pre-school age children and women at reproductive age ranged from 25% and 37% respectively4. Several studies have shown that untreated iron deficiency anemia can have a serious impact on health6-11.

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decreases plasma MDA\textsuperscript{17}.
Indonesia has a lot of plants with potential for
antianemia and antioxidants therapy, such as
\textit{Sauropus androgynous} and \textit{Moringa oleifera}\textsuperscript{16-21}.
\textit{Sauropus androgynous} and \textit{Moringa oleifera}
leaves are commonly consumed as leafy
vegetable. These plants are easy to be found and
used. \textit{Sauropus androgynous} leaves contain
higher Fe than \textit{Moringa oleifera}. However, the
utilization of \textit{Sauropus androgynous} leaves as
antianemia therapy should consider the safety range
of the dose. There was a report on that outbreak
of bronchiolitis obliterans after the consumption
of \textit{Sauropus androgynous} leaf juice\textsuperscript{22}.
\textit{Sauropus androgynous} and \textit{Moringa oleifera} leaf have
a complementary macronutrient and micronutrient
compositions. The composition of minerals and
vitamins per 100 g of fresh leaf of \textit{Sauropus androgynous}
contains 8.8 mg Fe, 543 mg P, 771 mg Ca 5600 mg
carotene, 0.50 mg thiamine, 244 mg vitamin C and 0.21 mg riboflavin while 100 g \textit{Moringa oleifera}
fresh leaves contains 7 mg Fe, 70 mg P, 440 mg Ca, 6780 mg carotene, 0.07 mg thiamine, 240 mg vitamin C and 0.39 mg riboflavin(22). \textit{Moringa oleifera} leaves also contain
a higher total phenolic, flavonoid and ascorbic
acid than its fruit and seeds. \textit{Moringa oleifera} ,
respectively of 105.04 mg galicequivalen acid
(GAE) / g 31.28 quercetin equivalent (QE) / g and 106.95 mg / 100 g\textsuperscript{23}. Some studies
have proven antioxidant potential of \textit{Moringa oleifera}
leaves against free radicals and prevent
oxidative stress\textsuperscript{24,25}. The combination of \textit{Sauropus androgynous}
leaf extract and \textit{Moringa oleifera} leaves may have a synergistic effect on
anemia and become an alternative to Fe
supplementation. This study was aimed to compare
the antianemic effect of \textit{Moringa oleifera} and
\textit{Sauropus androgynous} leaf extract alone and their
combination.

**Methods**

**Induction of iron deficiency anemia in rats**

Thirty female wistar strain rats weighed 190-220 g
were adapted for 7 days then randomly divided into
5 groups: normal, iron deficiency anemia
(IDA), \textit{Sauropus androgynous} (Sa), \textit{Moringa oleifera}
(Mo) and combination of \textit{Sauropus androgynous}
and \textit{Moringa oleifera} (SaMo). Each
group consisted of 6 rats. The rats were fed with
iron-deficiency diet (AIN-93 M) for 7 days\textsuperscript{11} while
6 rats in the normal group were given a standard diet.

**Plasma collection and analysis**

The blood samples were obtained from
blood orbital sinus on day 8 and day 29. Blood
samples added with heparin were centrifuged
and the plasma were stored at -20 ° C for further
analysis. cyamnmethemoglobin hemoglobin and
ferritin concentration were evaluated with
spectrophotometer. MDA level was evaluated with
barbituric thio acid reactive system (TBARS) using a
spectrophotometer. Measurements were conducted at
the Center for Food and Nutrition Studies of Gadjah
Mada University Yogyakarta.

**Dose of Extract**

Dosage used for leaf extract of \textit{Sauropus androgynous}
was 300mg/day, while the leaf extract of \textit{Moringa oleifera}
was 80 mg/day. The combination extract consists the combinations
of \textit{Sauropus androgynous} (150 mg/day) and \textit{Moringa oleifera}
(40mg/day) . The extracts were prepared
with a 70% ethanol using maceration method. The leaves
were obtained from Sleman, Yogyakarta
Indonesia.

**Statistical analysis**

Statistical analysis for mean differences of
hemoglobin and MDA before and after the treatment
were analyzed using One Way ANOVA test followed
by LSD Post Hoc test with a significance value of
p <0.005 (table 1). The mean difference in
hemoglobinserum, ferritin and MDA level prior
to the treatment with extract were analyzed with
Kruskal Wallis test followed by Mann Whitney test
with significance value of p <0.005 (table 1) . The
mean difference of hemoglobin, serum ferritin and
MDA level in each group before extract and after
administration of extract was analyzed using paired
sample T-Test.

**Ethical clearance**

The ethical clearance for this research was
obtained from Bioethics Commission of Medical
/ Health Research Faculty of Medicine Sultan
Agung Islamic University Number 01/1/2018
/ Bioethics Commission

**Results**

The mean of hemoglobin and ferritin
level in iron deficiency anemia (IDA), \textit{Sauropus androgynous} ( Sa ) , \textit{Moringa oleifera} (Mo ) and
combination of \textit{Sauropus androgynous} and \textit{Moringa oleifera} (SaMo ) fed with iron deficient diet for 7
days was significantly lower than those of the normal
group. In contrast, the mean MDA levels in the
IDA, Sa, Mo and SaMo groups fed with iron
deficient diet for 7 days was higher and significantly different from those of normal group. The mean haemoglobin, ferritin serum and MDA level in IDA, Sa, Mo and SaMo combination fed with iron deficient for 7 days did not show significant differences (Table 1).

After the treatment for 21 days, the mean of hemoglobin and ferritin levels in the 3 treatment groups were higher than IDA group and lower than the normal group. In contrast, the mean MDA in the treatment group showed a lower concentration than the IDA group, but higher than normal group (Table 1). The mean hemoglobin, ferritin and MDA after administration of the combination SaMo extract has been shown to be comparable to that of normal group. Likewise, the highest mean difference of hemoglobin and ferritin was found in the group given the combination extract SaMo. The mean difference in hemoglobin and ferritin in Sauropus androgynous group was higher than that of in Moringa oleifera.

**Table 1. Mean and Standard Deviation of Hemoglobin, Ferritin and MDA level**

| Variables   | Time  | Normal | IDA     | Sa     | Mo     | Combination of SaMo | p       |
|-------------|-------|--------|---------|--------|--------|----------------------|---------|
| Hb (g/dl)   |       |        |         |        |        |                      |         |
| D-8         |       | 14 ± 0.14               | 9.2 ± 0.34   | 8.8 ± 0.39   | 9.15 ± 0.32          | 9.08 ± 0.16          | 0.180*  |
|             | D-29  | 13.7 ± 0.29               | 8.9 ± 0.27   | 12.02 ± 0.26   | 10.57 ± 0.33          | 12.81 ± 0.18          | 0.000*  |
| Δ           |       | -0.29 ± 0.19               | -0.25 ± 0.12   | 3.21 ± 0.58   | 1.42 ± 0.55          | 3.37 ± 0.24          | 0.000** |
| Ferritin (µg/l) |     |        |         |        |        |                      |         |
| D-8         |       | 41.6 ± 0.93               | 9.3 ± 0.48   | 10.06 ± 0.20   | 9.73 ± 0.83          | 9.69 ± 0.83          | 0.212** |
|             | D-29  | 40.73 ± 1.06               | 9.21 ± 0.48   | 35.39 ± 0.38   | 33.9 ± 0.33          | 39.15 ± 0.51          | 0.000*  |
| Δ           |       | -0.87 ± 0.60               | -0.16 ± 0.19   | 25.33 ± 0.52   | 24.17 ± 1.30          | 29.46 ± 0.94          | 0.000** |
| MDA (nmol/ml) |      |        |         |        |        |                      |         |
| D-8         |       | 1.64 ± 0.13               | 8.1 ± 0.24   | 8.16 ± 0.46   | 8.1 ± 0.22          | 8.19 ± 0.33          | 0.961*  |
|             | D-29  | 1.83 ± 0.12               | 8.3 ± 0.21   | 2.92 ± 0.20   | 3.6 ± 0.15          | 2.3 ± 0.16           | 0.000*  |
| Δ           |       | 0.20 ± 0.11               | 0.20 ± 0.14   | -5.23 ± 0.65   | -4.50 ± 0.37         | -5.82 ± 0.46         | 0.000*  |

* One Way Anova test, **Kruskal Wallis test. At D-8 the value of p between the IDA, Sa, Mo and combination groups, when compared to the normal group then p = 0.000. Different letters indicatesignificant differences p <0.005

**Discussion**

Iron is a major component needed in the formation of hemoglobin and erythropoiesis. In this current study, induction of AIN93-M-MX deficiency diet for 7 days were success in making iron deficiency in anemia rats marked by decreased level of serum hemoglobin and ferritin concentration by 35% and 77% respectively compared to the normal group given standard diet. Serum ferritin is an indicator that leads to iron storage in the body, where 1 µg/L of serum ferritin is equivalent to 120 µg of iron deposits per kg body weight. The decrease of serum ferritin signifies an iron depletion.

Sauropus androgynous leaves containing chlorophyll...
have been shown to have antiemetic effect in female rats induced by sodium dinitrate, while the administration of *Moringa oleiefera* leaves also have been shown to have higher anti-anemic activity compared to iron tablet supplementation\(^{21}\). This may be due to the Fe content in fresh leaves of *Sauropus androgynous* higher than fresh leaves *Moringa oleiefera*. In this study, the administration of combination leaf extract of androgynous *Sauropus* and *Moringa oleiefera* for 21 days may increase mean haemoglobin and ferritin plasma in anemic rats. However, in this study, the number of Fe in each extract was no established. Interestingly, in the combination group of *Sauropus androgynous* leaves - *Moringa oleiefera* was found to have the highest increase by 41.08% and 75.25% respectively. The combination of *Sauropus androgynous* leaves and *Moringa oleiefera* may have a synergistic effect on anemia. The previous study showed that the 35 mg Fe diet from *Moringa oleiefera* effect on gene expression of liver hepcidin, transferrin, TRF-2, and ceruloplasmin\(^{21}\). Iron is required for the production of hemoglobin. The decrease of hemoglobin will cause the decrease of oxygen concentration in the body that can cause hypoxia. Hypoxia leads to oxidative stress. In iron deficiency anemia the concentration of SOD, CAT and GPx antioxidant enzymes are decreased\(^{17,26,27}\). Hypoxia and decreased concentrations of antioxidant enzymes play a role in lipid peroxidation and oxidative stress in erythrocytes. Oxidative stress on the erythrocyte membrane can cause erythrocytes in iron deficiency anemia to have higher rigidity than normal cells\(^{28}\) so that erythrocyte is prone to undergo eryptosis\(^{29}\). The degree of oxidative stress in this study was measured from the concentration of malondialdehyde (MDA).

On the other hand, post-supplementation of Fe tablets indicated an increase in lipid peroxidation through fenton reactions, damaging proteins and nucleic acids and causing oxidative stress\(^{15,30}\). Previous research shown that supplementation of Fe tablets at the dose of 4.8 mg/100g BW for 4 weeks increase MDA concentration of rat liver and decrease SOD concentration and GPx\(^{15}\). The addition of antioxidant vitamins A, C and E in Fe supplementations can decrease MDA concentration and increase the concentration of GPx enzyme\(^{17}\).

Supplementation of combination extract of *Sauropus androgynous-Moringa oleiefera* leaves for 21 days can lowered the MDA concentration by 71.19%. These effects may be associated with a higher increase in Hb levels in the combination group so as to bind more oxygen than the extract alone. In addition, these effects may be correlated with antioxidant components of *Sauropus androgynous-Moringa oleiefera* leaves extract combination.

**Conclusion**

The combination of the leaves extract of *Sauropus androgynous* and *Moringa oleiefera* (SaMo) have increase hemoglobin and ferritin and lower MDA level compared to single extract in diet anemia-induced rats.

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**Conflict of interest**

The researcher has no conflict of interest in this publication

**Contribution of authors:**

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