RESEARCH ARTICLE

Cookies rich in iron (Fe), folic acid, cobalamin (vitamin B12), and antioxidants: a novel functional food potential for adolescent with anemia [version 2; peer review: 1 approved, 1 approved with reservations]

Alexander Sam Leonard Bolang1, Mochammad Rizal2, Fahruıl Nurkolis3, Nelly Mayulu1, Nurpudji Astuti Taslim4, Son Radu5, Mrinal Samtiya6, Youla Annatje Assa7, Hendra Agung Herlambang2, Alpinia Shinta Pondagitan1, Christopherous Diva Vivo8

1Food and Nutrition, Sam Ratulangi University, Manado, North Sulawesi, 95115, Indonesia
2Division of Nutritional Sciences, Cornell University, Ithaca, New York, 14850, USA
3Biological Sciences, State Islamic University of Sunan Kalijaga (UIN Sunan Kalijaga Yogyakarta), Yogyakarta, Yogyakarta, 55281, Indonesia
4Nutritional Sciences, Hasanuddin University, Makassar, South Sulawesi, 90245, Indonesia
5Food Sciences, Universiti Putra Malaysia, Selangor Darul Ehsan, 43400, Malaysia
6Nutrition Biology, Central University of Haryana, Haryana, 123031, India
7Biochemistry Department, Sam Ratulangi University, Manado, North Sulawesi, 95115, Indonesia
8Dentistry, University of Indonesia, Depok, 16424, Indonesia

Abstract

Background: Anemia is a global public health problem, including Indonesia with 32% of adolescents are anemic. This study aims to process porang flour, moringa leaves, and tempe into cookies that are high in iron (Fe), folic acid, cobalamin (vitamin B12), and antioxidants as potential functional food snacks for adolescents with anemia.

Methods: This study is experimental with a completely randomized trial design (CRD) with three treatments and replications. There are three comparison formulations of a combination of porang, moringa leaves, and black soybean-based tempe; respectively F1 (91:3:3:3)%, F2 (85:3:6:6)%, and F3 (77:3:10:10)%. The cookie sample was then analyzed for water content, ash, iron, folic acid, cobalt, and antioxidant activity. The differences between the samples were analyzed based on the activity of antioxidants, iron, folic acid, and vitamin B12 (cobalamin) in data obtained from triplicates using multivariate ANOVA analysis.

Results: The results of the ash and water content tests of all three cookie formulations showed values in accordance with the Indonesian Open Peer Review

First published: 25 Oct 2021, 10:1075
https://doi.org/10.12688/f1000research.74045.1

Latest published: 04 Nov 2022, 10:1075
https://doi.org/10.12688/f1000research.74045.2
National Standard (SNI) for cookie products. F3 has significantly higher iron, folic acid, and cobalt levels than F1 and F2 (p<0.05). Antioxidant activity is highest in F3, but there is no statistical difference between F2 and F3 (p>0.05).

**Conclusions:** The combination of porang's tubers, moringa leaves, and tempe made from black soybeans, especially F3, has the potential to be used as a functional cookie processed product source of iron (Fe), folic acid, cobalamin, and antioxidants for adolescent anemia.

**Keywords**
Iron, Folic Acid, Cobalamin, Antioxidant, Anemia, Functional Food, Cookies

This article is included in the Agriculture, Food and Nutrition gateway.

**Corresponding authors:** Alexander Sam Leonard Bolang (bolangasl@gmail.com), Mochammad Rizal (mr855@cornell.edu), Fahrul Nurkolis (20106040012@student.uin-suka.ac.id)

**Author roles:** Bolang ASL: Conceptualization, Data Curation, Investigation, Writing – Original Draft Preparation, Writing – Review & Editing; Rizal M: Data Curation, Formal Analysis, Funding Acquisition, Writing – Original Draft Preparation, Writing – Review & Editing; Nurkolis F: Conceptualization, Investigation, Writing – Original Draft Preparation, Writing – Review & Editing; Mayulu N: Conceptualization, Supervision, Validation, Writing – Review & Editing; Taslim NA: Supervision, Validation, Writing – Review & Editing; Radu S: Formal Analysis, Writing – Review & Editing; Samtiya M: Writing – Review & Editing; Assa YA: Writing – Review & Editing; Herlambang HA: Writing – Review & Editing; Pondagitan AS: Writing – Review & Editing; Vivo CD: Writing – Review & Editing

**Competing interests:** No competing interests were disclosed.

**Grant information:** Lembaga Pengelola Dana Pendidikan, Indonesia Endowment Fund for Education (LPDP: Lembaga Pengelola Dana Pendidikan) Ministry of Finance, Republic of Indonesia.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Copyright:** © 2022 Bolang ASL et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**How to cite this article:** Bolang ASL, Rizal M, Nurkolis F et al. Cookies rich in iron (Fe), folic acid, cobalamin (vitamin B12), and antioxidants: a novel functional food potential for adolescent with anemia [version 2; peer review: 1 approved, 1 approved with reservations] F1000Research 2022, 10:1075 https://doi.org/10.12688/f1000research.74045.2

**First published:** 25 Oct 2021, 10:1075 https://doi.org/10.12688/f1000research.74045.1
Introduction

Anemia is a serious public health problem faced by all countries in the world. According to the World Health Organization (WHO), 42% of children <5 years, 33% of women of productive age, and 40% of pregnant women in the world have anemia. In Indonesia, Basic Health Research (Riskesdas) shows an increase in the prevalence of anemia in adolescents aged 15-24 years. In 2007, the prevalence of adolescent anemia in Indonesia was only 6.90% (Riskesdas, 2007), which then increased to 18.40% in 2013 (Riskesdas, 2013) and 32% in 2018 (Riskesdas, 2018). The impact of anemia is complex, ranging from immunity (Hasan et al., 2016) to work productivity (Blakstad et al., 2020), growth (Soliman et al., 2009) to intelligence (Bahrami et al., 2020), and physical fitness (Tsai et al., 2019) to maternal, fetal and child health (Georgieff, 2020).

Various interventions need to be done to speed up the treatment of anemia. In recent years, anemia prevention and treatment research among children and adolescents in Indonesia has been largely relying on nutritional education (Zuraida et al., 2020; Sari et al., 2018). Additionally, The government of Indonesia has its official program, namely the provision of iron and folic acid supplementation in the form of Blood Added Tablets (TTD) in school-aged teenagers. Although the program's scope is quite high, which is 76.2%, its effectiveness is relatively low because only 2.13% consume TTD as recommended ≥52 items per year (Riskesdas, 2018). Moreover, a study by Apriningsih et al., 2020 stated that highschool female’s adherence to consume iron-folic acid tablets in Depok was relatively low (45.6%). Other similar study found that adolescent girls who consumed at least one tablet per week was only 9% and 18% in East Nusa Tenggara and East Java, respectively (Alfiah et al., 2020). Therefore, alternative efforts such as food fortification become important to do, especially in snacks that are mostly preferred by teenagers. In addition to promising results in terms of decreasing the problem of micronutrient deficiency (Dewi & Mahmudiono, 2021), food-to-food fortification in snacks is also potentially effective because adolescents aged 18-25 years tend to consume snacks ≥3 times per day which contributes to 25% recommended dietary allowance (RDA) or average daily dietary intake level (USDA, 2012).

Many local Indonesian foodstuffs are of high nutritional value (Permatasari et al., 2021), for example, porang tubers. Porang's tubers (Amorphophallus oncophyllus) can be used as potential glucomannan source flour in Indonesia (especially the original regency, Madiu, East Java, Indonesia) because of the high glucomannan content (Harmayani et al., 2014). The bulbs are cultivated in Indonesia as secondary plants under teak, mahogany, and sonokeling plantations (Yanuriati et al., 2017). As a source of glucomannan, people have many benefits as functional foodstuffs (Harmayani et al., 2014; Yanuriati et al., 2017). Glucomannan properties can bind to other components such as proteins, minerals, and active compounds such as antioxidants that form a matrix of tissues in the food developed from it (Herlina et al., 2015). Glucomannan has been widely used in the food industry as a thickener, gel-forming, texture, water binder, and emulsion stabilizer, including in cookie making (Imeson, 2009; Mikkonen et al., 2009; Zhang et al., 2005). However, apart from having a high glucomannan content, Wardani and Arifiyana (2020) found that porang tubers also contain high levels of calcium oxalate (2.6030% w/w) that should be considered since it can cause itchy mouth, irritation, and trigger the development of kidney stones (Ulfa & Nafi’ah, 2018).

In addition to porang's tubers, another local foodstuff that is also known to have many health benefits is moringa leaves. Moringa oleifera is known as an excellent food source that is easy to digest and rich in protein (Fahey, 2005). According to Sultana and Anwar (2007), moringa leaves have many valuable compounds such as protein, vitamins, calcium, iron, folic acid, and antioxidants (carotenoids, flavonoids, and phenols) (Sultana & Anwar 2007). Various developing countries in the world feed their children with moringa (Kasolo et al., 2010). Busani et al. (2011) reported that the presence of various minerals and vitamins helps boost immunity against various diseases, especially moringa leaves contain various amino acids (Busani et al., 2011). In addition, the levels of iron, folic acid, and antioxidants contained in it also have the potential to become an anti-anemia agent (Mo et al., 2013; Kurtoglu et al., 2003). On the other hand,
moringa oleifera also contains 5% saponins and 3.1% phytate, which are considered as anti-nutritional factors (Makkar et al., 1996).

Indonesia’s third potential foodstuff, which has been known globally, is tempe. Tempe is made from soybeans fermented by *Rhizopus* spp mushrooms such as *R. oligosporus*, *R. stolonifer*, and *R. oryzae* with several characteristics such as white, compact texture, and mixed distinctive flavors of mushrooms and soy flavors (Astuti et al., 2013). Black soybean tempe has potential functional characteristics, as black soybeans contain phenolics, tannins, anthocyanins, cobalamin (B12), and isoflavones, as well as a higher antioxidant activity than yellow soybeans (Xu dan Chang, 2007). According to Nurrahman et al. (2011), black soybean tempe has the same level of fondness as yellow soybean tempe, and its antioxidant activity is higher (Nurrahman et al., 2011). In addition, Vitamin B12 (Cobalamin) in the tempe has the potential in the formation of red blood cells and its antioxidants to overcome red blood cell damage (Mo et al., 2013; Kurtoglu et al., 2003).

Therefore, the combination of porang’s tubers, moringa leaves, and tempe made from black soybeans can be used as processed products such as functional cookies as a snack for anemia adolescents. This study utilizes and formulates all three ingredients into functional cookies and determines levels of iron (Fe), folic acid, cobalamin (vitamin B12), and antioxidants.

**Methods**

This study is experimental with a completely randomized trial design (CRD) with three treatments and triplicates, and only moringa leaf flour and tempe flour (black-soybean) ingredients are differentiating treatments with a percentage increase in each formulation (see Table 1), the rest are the same or controlled. Ingredients or materials including porang flour, moringa leaf flour, tempe flour (black-soybean), stevia, skimmed milk, egg yolk, baking powder and margarine are obtained or purchased from the market in Yogyakarta, Indonesia and are in accordance with the Indonesian National Standard (SNI).

**Cookies formulation**

Cookie processing

Cookie making refers to Nugraha (2009), which consists of the preparation of materials, dough formation (cream formation and flour mixing), dough printing, roasting, refrigeration, and packaging. The preparation of materials starts from weighing the material according to treatment. The formation of the dough begins by mixing margarine, egg yolk, stevia sugar powder, and baking powder using a mixer (Philips HR1559) so that cream is formed (Table 1). Furthermore, we added flour, moringa leaf flour (freeze-drying methods with Lyovapor L-200 this material purchased from the market in Yogyakarta), and tempe flour (made from black soybean), corresponding to the treatment. Then the dough is formed into sheets and printed using a molding tool. Cookies are then put into the oven (Sharp EO-28LP) at 140°C for 15-20 minutes. After the cookies are done cooking, the cookies are then cooled so that the cookies are perfectly served.

**Ash levels and water content analysis**

The procedure for determining ash levels was carried out using the Official Methods of Analysis of Association of Official Agricultural Chemists (AOAC) International 2005 (AOAC 2005). First, the cup was dried in the oven

**Table 1. Cookies formulation.**

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>F1 (%)</th>
<th>F2 (%)</th>
<th>F3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porang Flour</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Moringa Leaf Flour</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Tempe Flour (Black-Soybean)</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Stevia</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Skimmed Milk</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Egg Yolk</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Baking Powder</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Margarine</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>
(MEMMERT UN30 Oven Lab 32 L / MEMMERT UN 30 Universal Oven) at a temperature of 105°C for one hour. Then, the cup was cooled for 15 minutes in a desiccator and weighed. A sample of 2 grams was put into a furnace with a temperature of 550°C for three hours. It was then cooled outside the furnace until the temperature was ± 120°C and put into a desiccator (Duran Vacuum Desicator) to remove purified water and crystals. Plates and ash were weighed so that constant weight was obtained. The formula is calculated with reference to the author’s previous study (Permatasari et al., 2022).

The determination of the moisture content used was the AOAC method of drying (thermogravimetry). The principle of this method was based on the evaporation of water in materials by heating, then weighing to a constant weight. The weight loss that occurred is the water content contained in the material. The empty plate was heated in the oven at 105°C for 30 minutes, cooled in a desiccator for 15 minutes, then weighed (W0). A sample of 2 grams was then put in a cup that had a known weight, weighed (W1), then dried in the oven at a temperature of 105°C for three hours, cooled in a desiccator for 15-30 minutes, then the cup and its contents were weighed, re-dried for an hour, cooled in an extractor, and re-weighed (W2).

Iron (Fe) ortho-phenantroline analysis
The principle of determining total iron content by the method o-phenanthroline was the same as the method of \( \alpha, \alpha' \) – the principle of iron (III) was reduced by hydroxyl amen to form iron (II). Iron (II), both present in foodstuffs and iron reduction (III), was then reacted with o-phenanthroline to form a red Fe-phenanthroline complex that can be measured with visible spectrophotometers at a wavelength of 510 nm. This method refers to other appropriate studies (Fayaz et al., 2005).

Folic acid and B12 (cobalamin) analysis
This method refers to other appropriate studies (Perveen et al., 2009). This analysis used HPLC-UV with a gradient elevation system in which the composition of the phase of motion changes during the measurement process. The phase of motion used was dapar phosphate 10 mM pH 4, and the dapar phosphate mixture: acetonitrile, 7:3. As a stationary phase, the Atlantis column T3 C18 (4.6 mm × 150 mm), 5 μm was used. Oven temperature were 35 °C, with a flow rate of 0.5 mL/min and injection volume of 20 μL. UV detectors were set at wavelengths of 280 for folic acid and 275 nm for cobalt (vitamin B12). A raw solution of cobalt (vitamin B12) with a concentration of 2 μg/mL and folic acid of 0.4 μg/mL was injected into HPLC of 20 μL under appropriate analytical conditions.

Antioxidant activity assay
Antioxidant activity was determined using DPPH (2,2-diphenyl-1-pikrilhydrazil). Each sample consisting of 100 dL was placed in a microplate of 96 and added 100 L DPPH 0.3 mM, then incubated for 30 minutes in a dark room. The absorbance of the sample was measured using an ELISA reader (# Allsheng) at a wavelength of 517 nm. The formula is calculated with reference to the author’s previous study (Permatasari et al., 2022).

Table 2. Tests of normality.

<table>
<thead>
<tr>
<th>Formulasi</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>Fe (mg/100 g)</td>
<td>F1</td>
<td>.322</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>.212</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>.382</td>
</tr>
<tr>
<td>Folate (mcg/100 g)</td>
<td>F1</td>
<td>.270</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>.249</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>.358</td>
</tr>
<tr>
<td>B12 (mcg/100 g)</td>
<td>F1</td>
<td>.212</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>.297</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>.227</td>
</tr>
<tr>
<td>Antioxidant activity (%)</td>
<td>F1</td>
<td>.216</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>.283</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>.253</td>
</tr>
</tbody>
</table>

Based on the normality test results above, the data obtained is homogeneous (p > 0.05), followed by the Anova multivariate test.

*aLilliefors significance correction.*
Data management and analysis
Statistical analysis was done using SPPS 26.0 for apple’s version of MacBook. The differences between the samples were analyzed based on the activity of antioxidants, iron, folic acid, and vitamin B12 (cobalamin). Data obtained from three repeats (triplicates) was analyzed with multivariate ANOVA at 95% CI (p < 0.05). The result was declared significant if the p-value < 0.05 with normality test shown in Table 2.

Results
Test of normality
The results of the ash and water content tests of the three cookie formulations above showed a value in accordance with the Indonesian National Standard for cookie products (SNI 01-2973-1992) (Table 3), which is a maximum ash content of

Table 3. Results of ash levels and water content analysis.

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Ash</th>
<th>Moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>1.30 ± 0.35</td>
<td>3.42 ± 1.35</td>
</tr>
<tr>
<td>F2</td>
<td>1.37 ± 0.07</td>
<td>3.76 ± 1.26</td>
</tr>
<tr>
<td>F3</td>
<td>1.46 ± 0.16</td>
<td>3.73 ± 1.77</td>
</tr>
</tbody>
</table>

Table 4. Multiple comparisons.

<table>
<thead>
<tr>
<th>Tukey HSD</th>
<th>Dependent variable</th>
<th>(I) Formulasi</th>
<th>(J) Formulasi</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fe (mg/100 g)</td>
<td>F1</td>
<td>F2</td>
<td>1.81667*</td>
<td>.47005</td>
<td>.019</td>
<td>.3744 3.2589</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>-.41667*</td>
<td>.47005</td>
<td>.000</td>
<td>-5.6089 -2.7244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>-1.81667*</td>
<td>.47005</td>
<td>.019</td>
<td>-3.2589 -3.744</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>-5.98333*</td>
<td>.47005</td>
<td>.000</td>
<td>-7.4256 5.6089</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F1</td>
<td>4.16667*</td>
<td>.47005</td>
<td>.000</td>
<td>2.7244 5.6089</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>-4.58333*</td>
<td>.47005</td>
<td>.000</td>
<td>7.4256 4.5411</td>
</tr>
<tr>
<td></td>
<td>Folate (mcg/100 g)</td>
<td>F1</td>
<td>F2</td>
<td>4.65333*</td>
<td>.71293</td>
<td>.002</td>
<td>2.4659 6.8408</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>-4.79000*</td>
<td>.71293</td>
<td>.001</td>
<td>-6.9775 -2.6025</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>-4.65333*</td>
<td>.71293</td>
<td>.002</td>
<td>-6.8408 -2.4659</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F1</td>
<td>-9.44333*</td>
<td>.71293</td>
<td>.000</td>
<td>-11.6308 -7.2559</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>4.79000*</td>
<td>.71293</td>
<td>.001</td>
<td>2.6025 6.9775</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>9.44333*</td>
<td>.71293</td>
<td>.000</td>
<td>7.2559 11.6308</td>
</tr>
<tr>
<td></td>
<td>B12 (mcg/100 g)</td>
<td>F1</td>
<td>F2</td>
<td>5.39000*</td>
<td>1.02781</td>
<td>.005</td>
<td>2.2364 8.5436</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>-6.31667*</td>
<td>1.02781</td>
<td>.002</td>
<td>-9.4703 -3.1631</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>-5.39000*</td>
<td>1.02781</td>
<td>.005</td>
<td>-8.5436 -2.2364</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F1</td>
<td>-11.70667*</td>
<td>1.02781</td>
<td>.000</td>
<td>-14.8603 -8.5531</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>11.70667*</td>
<td>1.02781</td>
<td>.000</td>
<td>8.5531 14.8603</td>
</tr>
<tr>
<td></td>
<td>Antioxidant activity (%)</td>
<td>F1</td>
<td>F2</td>
<td>3.46667</td>
<td>1.42911</td>
<td>.112</td>
<td>-.9182 7.8516</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>-2.14667</td>
<td>1.42911</td>
<td>.355</td>
<td>-6.5316 2.2382</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>-3.46667</td>
<td>1.42911</td>
<td>.112</td>
<td>-7.8516 .9182</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F1</td>
<td>-5.61333*</td>
<td>1.42911</td>
<td>.018</td>
<td>-9.9982 -1.2284</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F3</td>
<td>F2</td>
<td>2.14667</td>
<td>1.42911</td>
<td>.355</td>
<td>-2.2382 6.5316</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F2</td>
<td>F1</td>
<td>5.61333*</td>
<td>1.42911</td>
<td>.018</td>
<td>1.2284 9.9982</td>
</tr>
</tbody>
</table>
Figure 1. **F3 cookie has the highest Fe content.** In formulation 3 (F3) based on multivariate results, iron (Fe) levels were 29.41 ± 0.65 mg/100 g, significantly higher than F1 and F2 (p < 0.05).

Figure 2. **F3 cookie has the highest folic acid content.** In formulation 3 (F3) based on multivariate results, folic acid (vitamin B9) or folate levels were 308.24 ± 1.30 mcg/100 g, significantly higher than F1 and F2 (p < 0.05).

Figure 3. **F3 cookie has the highest cobalamin content.** In formulation 3 (F3) based on multivariate results, the levels of vitamin B12 (cobalamin) owned amounted to 109.76 ± 1.74 mcg/100 g, higher than F1 and F2 significantly (p < 0.05).
Formulation 3 (F3) is a high iron cookie, amounting to 29.41 ± 0.65 mg/100 g, higher than F1 and F2 significantly (p < 0.05) (Table 4; Figure 1). In the scheme (Figure 3), iron is needed by the body for erythropoiesis or the process of red blood cell synthesis, precisely as the constituent material of hemoglobin (Singh, 2018). F3 cookies in this study have higher iron levels than the functional cookies of previous research 2020 which only has a level of 2.51 mg/100 g (Rahmat et al., 2020). In line with AKG (Angka Kecukupan Gizi) Indonesia in 2019, iron adequacy rates for ages 10-18 years in men range from 8-11 mg, in women 8-15 mg per person per day. Seeing this, F3 cookies are potentially a food source of iron, especially for adolescents with anemia.

In addition to iron height, F3 cookies have a fairly high antioxidant content of 24.41 ± 1.31%, although there is no significant difference with F2 cookies (Table 4; Figure 4). In addition to needing iron food sources to avoid anemia is also needed foods that have antioxidant abilities to protect red blood cell damage due to the occurrence of oxidative stress (Reactive Oxygen Species) (Lobo et al., 2010; Gwozdzinski et al., 2021).

Folic acid or vitamin B9 and cobalt (vitamin B12) also have an important role in minimizing the incidence of anemia. Folic acid collaborates with vitamin B12 in making red blood cells and helps iron function properly in the
body (Figure 5) (Mahmood, 2014). Vitamin B9 works with vitamins B6 and B12 and other nutrients in controlling the amino acid homocysteine levels in increasing the effectiveness of red blood cell formation (Figure 5) (Mahmood, 2014). Formulation 3 (F3) is the best formulation when viewed from iron (Fe), folic acid (vitamin B9), cobalamin (vitamin B12), and antioxidant activity. F3 cookies have the highest levels of folic acid and cobalamine (308.24 ± 1.30 mcg/100 g and 109.76 ± 1.74 mcg/100 g) compared to F1 and F2 (Table 4, Figures 2 and 3). Cookie F3 has folic acid that is closest to AKG (Angka Kecukupan Gizi), which recommends 400 mcg per person per day (for men and women aged 10-18 years).

Cookie innovation made from a combination of porang’s tubers, moringa leaves, and tempe made from black soybeans has potential to be made a functional anti-anemia food or to minimize anemia comprehensively (see Figure 5). In addition, the sugar or sweetener used in this formulation is stevia which is clinically safer (not hyperglycemia) (Ashwell, 2015). However, further studies are needed in both experimental animals and humans to find out more about the clinical benefits.

**Conclusion**

The combination of porang's tubers, moringa leaves and tempe made from black soybeans, especially F3 has the potential to be used as a functional cookie processed product source of iron (Fe), folic acid, cobalamin, and antioxidants for adolescent anemia. As a novel functional food potential for adolescent with anemia, preclinical trials or in vivo trials on undernourished animal models and clinical trials on humans are urgently needed with reference to this Cookie F3.

**Data availability**

**Underlying data**


The project contains the following underlying data:

- Raw Data: Water and Ash Content, Iron (Fe), Folic Acid, Cobalamin, and Antioxidants.

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).


US Department of Agriculture, Agricultural Research Service: Snacks: percentages of selected nutrients contributed by food and beverages consumed at snack occasions, by gender and age, What We Eat in America, NHANES 2011-2012. [cited 2021 Aug 31].


Open Peer Review

Current Peer Review Status: ? ✓

Version 1

Reviewer Report 23 June 2022

https://doi.org/10.5256/f1000research.77755.r140091

© 2022 Indriani Y. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Yaktiworo Indriani
Department of Agribusiness, Fakulty of Agriculture, Universitas Lampung, Bandar Lampung, Indonesia

I think this article deserves to be indexed and has benefits for improving the health of adolescent women in Indonesia, especially reducing anemia through the consumption of cookies that are high in Fe, folic acid, Vitamin B12 and antioxidants. In general, I consider that the background and benefits of the research are clearly written. However, it is still found Indonesian, namely AKG (Angka Kecukupan Gizi), it must be translated into English as the Recommended Dietary Allowance (RDA). The data and processing are presented quite well through pictures but the discussion is too short and there is no comparison with the results of other studies. I hope that the author can provide an explanation why the content of Fe, Folate, vitamin B12 and antioxidants in F2 are lower than F1?

As a suggestion for further research, it is necessary to carry out a sensory evaluation of the cookies produced, considering that the addition of porang and tempeh can change the color, taste and aroma of the product.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Nutrition and Food

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 16 February 2022

https://doi.org/10.5256/f1000research.77755.r101869

© 2022 Alamu E. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Emmanuel Oladeji Alamu
Food and Nutrition Sciences Laboratory, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

Dear Editor,

This research article contains information on using porang tubers, moringa leaves, and tempe to develop cookies with high iron (Fe), folic acid, cobalamin (vitamin B12), and antioxidants for adolescents with anemia. The paper is not well written, and I have issues with the methodology, results, discussion, and conclusion sections. The methods were not well described and lacked basic information and references. These sections needed additional information. The authors should work on the results and discussion sections because they are not well presented in their current forms. The authors need to discuss their results better; currently, it lacks comparisons with the previous work on cookies.

I have the full comments directly inserted in the reviewed version of the manuscript that has been attached and can be accessed through this link: https://f1000researchdata.s3.amazonaws.com/supplementary/74045/5e3c9f70-90f1-4240-ac31-37489c75df0e.pdf

I recommend that the authors do thorough work on the manuscript by responding to all my comments before publication.

Thank you.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
No

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Food Science and Technology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

---

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com