COWPEA SPROUTED MILK RICH IN PHENOLIC ANTIOXIDANTS, VITAMIN C, PROTEIN, AND DIETARY FIBER AS AN ANTIDIABETIC DRINK

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Abstract

This study aimed to obtain a formula of Cowpea sprouted milk rich in phenolic, vitamin C, protein, and dietary fiber based on the duration of germination. The experimental study used a randomized block design with 0, 8, 10, and 12 hours germination time treatments, with 5 replications. Cowpeas were washed, soaked in warm water at 40°C for 10 hours, then drained in a basket, placed in a damp place, and sprayed with water once every 6 hours to germinate. Sprouts are washed, including the skin, blended with added water 8 times, filtered, so that a smooth liquid is obtained. Added 5% sugar into the smooth liquid, while stirring, is heated until it boils, called Cowpea sprout milk (CowpeaS-Milk). The product was determined for phenolic content (Follin Ciocalteau), vitamin C (Yodometry), fiber (oven), and soluble protein (Lowry). The data were tested using ANOVA, followed by the DMRT if there was a significant level of 5%. The duration of germination increased the levels of phenolic (P=0.003), fiber (P=0.02), soluble protein (P=0.05), and vitamin C (P=0.05). The best formula was obtained from CowpeaS-Milk with a germination time of 12 hours, containing phenolic antioxidants 4.67 mgGAE/g, vitamin C 75.8 mg/100g, dietary fiber 1.28%, and soluble protein 33%. Based on its nutritional content, CowpeaS-Milk is useful for people with Diabetes Mellitus.

Keywords: Cowpea sprouted milk, phenolic, fiber, protein, vitamin C

Introduction

The incidence of type-2 diabetes mellitus (T2DM) increases from year to year and is mostly experienced at the age of >30 years (Gómez-Huelgas *et al*., 2018). There are several triggers for the pathogenesis of T2DM, including inflammation and oxidative stress (Winarsi *et al*., 2016). It is stated that functional foods rich in antioxidants can overcome oxidative stress, suppress inflammatory markers, and control blood sugar levels (Burkar *et al*., 2017). One type of antioxidant-rich nut is Cowpeas.

Cowpeas *(Vigna unguiculata)* reported by Thangadurai (2005) contain protein 29.2%, fat 29.2%, fiber 4.9%, ash 3.6%, and energy 1,737 KJ/100 g, as well as minerals K 11.18 mg, Ca

22.63 mg, Na 96.4 mg, Zn 9.5 mg, Fe 4.47 mg, Cu 9.31 mg, Pb 2.24 mg, and P 421.58 mg/100 g. In addition to potential as antioxidants, Cowpeas have various pharmacological effects such as antidiabetic (Ashraduzzaman *et al*., 2011) and hypocholesterolemic (Weththasinghe *et al*., 2014). The high Zn content proves that Cowpeas have antioxidant potential (Winarsi *et al*., 2020), but the acceptance of Cowpea products is limited by the presence of beany flavor and anti-nutrients in it, so it needs pre-processing.

Germination, in addition to minimizing beany flavor, has also been reported to increase its protein and antioxidant content (Winarsi *et al*., 2020). All of the components that make up peanuts are degraded during germination, so that their glucose, fatty acid, and amino acid content increases. According to Ferdiawan and Nurwantoro (2019), the longer the germination time, the higher the protein content, as well as the phenolic, fiber, and vitamin C levels (Winarsi *et al*., 2021).

Ferdiawan and Nurwantoro (2019) reported that the highest protein content was found in Cowpeas with 24-hour germination. In the mung bean germination experiment conducted by Zhou (2019), with a time variable of 36, 48, and 72 hours it significantly increased total phenolics. This study was focused on getting sprouts with a length of 0.5-1.5 cm to obtain optimal antioxidant content so that the germination time was adjusted to local conditions.

The problem is, how is the Cowpea sprouted milk formula rich in phenolic antioxidants, fiber, vitamin C, and protein-based on germination time? This study aimed to determine the effect of germination time on the levels of phenolic, fiber, vitamin C, and protein of Cowpea sprouted milk, and to obtain the best formula.

Research Methods

This non-factorial experimental study used a Randomized Block Design, with variable germination times of 0, 8, 10, 12 hours with 5 replications.

a. Cowpea Germination Production (Wea *et al*., 2014; Winarsi *et al*., 2020)

Cowpeas are sorted and washed thoroughly, then soaked for 10 hours in warm water (40-45^{o}C), then drained and placed in a humid place, without light. Germination was carried out for 8 hours, 10 hours, and 12 hours. Every 6 hours, water is sprayed over the beans.

b Making Cowpea Sprout Milk (Winarsi *et al*., 2020 with slight modification)

Cowpea sprouts were washed with clean water without peeling the skin. Cowpea sprouts are blended with water, with the ratio of Cowpea sprouts: water = 1: 8, until a smooth liquid is obtained. As much as 5% sugar is added to the smooth liquid, cooked while stirring, until it boils, called CowpeaS-Milk.

c. Determination of the phenolic content of CowpeaS-Milk using the Folin-Ciocalteu method (Orak, 2006)

Take 1 ml of CowpeaS-Milk solution put it into a test tube and add 4 ml of distilled water. 0.2 ml of Folin-Ciocalteu reagent was added to the test tube. The mixture was allowed to stand for 5 minutes, then 1 ml of 5% Na2CO3 solution was added, and incubated for 1 hour in the dark. The absorbance was read by a spectrophotometer at a wavelength of 747 nm.

d. Determination of dissolved protein levels by the Lowry method (Goretti and Purwanto, 2014)

Lowry A was prepared by mixing Folin Ciocalteu reagent with distilled water (1: 1). Lowry B was prepared by preparing 50 ml of a solution (2% Na2CO3 0.1 N NaOH) + (1% CuSO4 + 1% Sodium Potassium Tartrate) in water. Take 1 ml of Cowpea sprout milk solution and put it in a test tube. Added 8 ml of Lowry's reagent B, and left for 10 min. Add 1 ml of Lowry's reagent A, shake, and leave for 20 minutes. The absorbance was read at a wavelength of 600 nm.

e. Vitamin C Analysis (Iodometric Method) (Sudarmadji *et al*., 1997)

Weighed 5 g of CowpeaS-Milk was put into a 100 ml volumetric flask and added with distilled water up to the mark. Filtered using filter paper to separate the filtrate. Take 5 ml of the filtrate using a pipette, and put it into an Erlenmeyer, add 2 ml of 1% starch solution. Titrate with 0.01 N iodine (I2) until a blue color. The content of vitamin C can be calculated using the formula:

$$\text{Vitamin C content (mg/100g)} = \frac{(\text{Vol I}^2 x\ 0{,}88\ x\ Fp)x\ 100}{\text{W sampel (g)}}$$

Notes: V I2 = Volume of iodine (ml); 0.88 = 0.88 mg of vitamin C is equivalent to 1 ml of 0.01 N I2 solution; Fp = dilution factor; Ws= Sample weight (g)

f. Fiber Content Analysis (Korompot *et al*., 2018)

Weighed 5 g of CowpeaS-Milk was put into an Erlenmeyer. As much as 50 ml of 0.313 N H_2SO_4 was added, then covered with aluminum foil and boiled for 30 minutes. Add 50 ml of 0.255 N NaOH and cover with aluminum foil, then boil again for 30 minutes. Filtered using filter paper that has been dried, which has been weighed before. The precipitate contained in the filter paper was flushed successively using hot 1.25% H_2SO_4, hot water, and 96% ethanol. The filter paper was put in a petri dish and heated in an oven at 105°C. After the weight of the filter paper is weighed, then the residual weight is calculated, using the final filter paperweight minus the initial filter paperweight, the amount of CowpeaS-milk fiber is obtained. The amount of fiber is calculated using the formula:

$$\text{Fiber content (\%)} = \text{(residual weight (gr))/(sample weight (gr))} \times 100\%$$

g. Data analysis

The data obtained was carried out by the One Way ANOVA test, followed by Duncan's Multiple Range Test (DMRT) at a level of 5% if there was significance. To get the best formula, it was determined using the effectiveness index test (DeGarmo *et al*., 1984).

Results and Discussion

1. Effect of Germination Time on Phenolic Levels of CowpeaS-Milk

The duration of germination increased the phenolic content of CowpeaS- milk ($P = 0.003$). The highest phenolic content was found in CowpeaS- milk with a germination time of 12 hours, which was 4.67 mg GAE/g (Figure 1). The results of this study are following the findings of Khang *et al*. (2016) who have germinated white Cowpeas, the phenolic content increased.

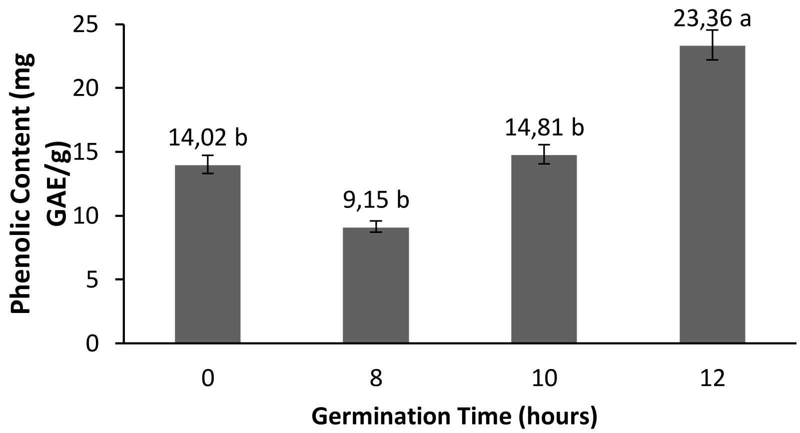

Figure 1. Effect of germination time on the phenolic content of Cowpea sprouted milk.
Note: Numbers followed by the same letter are not significantly different in the 5%.

Germination begins with soaking the beans in water. In this stage, water imbibition occurs into the beans, and activates biosynthetic enzymes, resulting in metabolic products in the form of phenolics and flavonoids (Bewley *et al*., 2013). During germination, beans undergo an elicitation process that activates the antioxidant defense system of phenolics and flavonoids to protect themselves from disturbances during growth.

The enzyme phenylalanine ammonia-lyase (PAL) catalyzes the elimination of ammonia molecules from cinnamic acid, then produces phenolic compounds as secondary metabolite products (Setyorini and Yusnawan, 2016). Therefore, the phenolic content of Cowpeas increased with the duration of germination.

In this study, the skin of the Cowpea sprouts was not removed but included in the manufacture of CowpeaS-Milk. Christman *et al*. (2018) stated that many phenolic compounds are present in the skin of nuts. Peanut shells contain high levels of phenolics, which act as a protective layer for the cotyledons. Nurjanati *et al*. (2018) stated that the phenolic content of sprouted red bean milk (without skin) was 337 mg GAE/L, lower than that of skinned red bean sprouted milk which was 452 mg GAE/L. Thus the manufacture of whole CowpeaS-Milk (complete with skin) can increase the levels of phenolic which has the potential as an antioxidant and beneficial for health.

2. Effect of Germination Time on Soluble Protein Content of CowpeaS-Milk

The duration of germination increased the soluble protein content of CowpeaS-Milk ($p = 0.05$), with the highest protein content of 33% (Figure 2). The results of this study support the findings Mardiyanto and Sudarwati (2015) who have germinated soybeans so that the dissolved protein content increased at 48 hours of germination because the water that was imbibed into the beans simultaneously included oxygen and became a means of transporting food reserves from the storage area to the embryo axis. In such conditions, the enzymes in it are activated for the synthesis of compounds needed for the formation of new cells, including protein compounds. During germination, proteins are hydrolyzed by protease enzymes into amino acids with smaller molecular weights and are water-soluble (Afify *et al*., 2011). Therefore, the duration of germination plays a role in increasing the soluble protein content of CowpeaS-Milk.

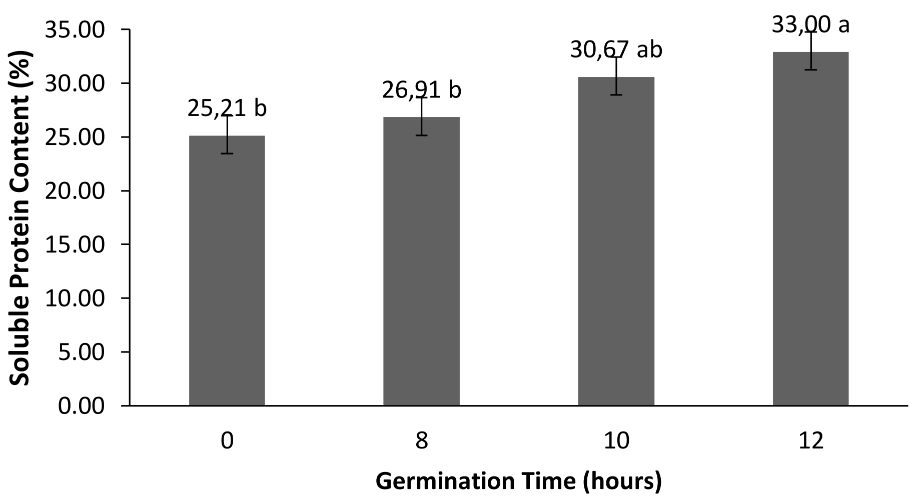

Figure 2. Effect of germination time on the soluble protein content of CowpeaS-Milk.
Note: Numbers followed by the same letter are not significantly different in the 5%.

Soluble protein is more easily extracted in water, so its levels in CowpeaS-Milk increase. Soluble protein is part of the total protein contained in foodstuffs that can be dissolved in water. It has a chain of less than 10 amino acids, so it is more easily digested by the human intestine (Winarsi *et al*., 2021).

c. Effect of Germination Time on Fiber Content of CowpeaS-Milk

The duration of germination increased the fiber content of CowpeaS-Milk (P=0.02), with the highest fiber content found in the 12-hour germination treatment, namely 1.28%, while the lowest was found in the 8-hour germination treatment (0.91%) (Table 1). The results of this study are in line with the findings of Megat *et al*. (2016), that there was a significant increase in dietary fiber in the germination of legumes, kidney beans, green beans, and soybeans. The increased fiber content in sprouts occurs due to the process of structural carbohydrate synthesis, namely the formation of new cellulose and hemicellulose which are the largest components of cell walls (Shah *et al*., 2011). Cellulose and hemicellulose are fiber compounds.

Table 1. Fiber content of CowpeaS-Milk based on germination time

Germination times (hours)	**Dietary fiber (%)**	**P *value***
0	$0{,}59 \pm 0{,}38^{a}$	
8	$0{,}91 \pm 0{,}03^{ab}$	0,02
10	$1{,}08 \pm 0{,}11^{b}$	
12	$1{,}28 \pm 0{,}11^{b}$	

Notes: Numbers followed by the same letter indicate that there is no significant difference in the 5%; n=3

In this study, the Cowpea sprouts were included in the manufacture of CowpeaS-Milk, because the Cowpea epidermis contains a lot of fiber such as cellulose. The addition of soybean husk can increase the fiber and protein content so that it can be used as a quality food product. This is in line with the research conducted by Safitri *et al*. (2017), the highest fiber content is found in Cowpea milk from Cowpea with skin, compared to Cowpea milk without skin. Another study also conducted by Khalid and Elhardallou (2016), the manufacture of flour made from Cowpeas with skin produces higher fiber compared to flour made from Cowpeas without skin.

d. Effect of Germination Time on Vitamin C Levels of CowpeaS-Milk

There was a significant effect of germination time on the increase in vitamin C levels of CowpeaS-Milk (P=0.05), with the highest levels found in milk with a germination time of 12 hours, namely 75.8 mg/100g, and the lowest at 8 hours of germination (64.08 mg/100g) (Table 2).

Table 2. Vitamin C Levels of Cowpea Sprout Milk by Germination Time

Germination Time (Hour)	Vitamin C (mg/100g)	P-*value*
0	46,52±8,8^{a}	0,05
8	64,08±10,5^{ab}	
10	67,38±13,6^{ab}	
12	75,80±9,07^{b}	

Notes: Numbers followed by the same letter indicate no significant difference in the 5%; n=3.

The results of this study support the findings of Masood *et al*. (2014) that vitamin C levels increased in sprouted beans, due to the activity of the enzyme L-Galactono-gamma-lactone dehydrogenase catalyzing the oxidation of L-galactono-1, 4-lactone to ascorbic acid, or vitamin C. The enzyme L-Galactono-gamma- lactone dehydrogenase is a key enzyme in ascorbic acid biosynthesis; the longer germination the enzyme activity increased significantly so that the ascorbic acid level increased. Germination time of 12 hours showed vitamin C content of CowpeaS-Milk was 75.80 mg/100g, higher than other germination.

Vitamin C is one of the nutrients needed by the body. This vitamin is usually found in fruits and vegetables. The vitamin C content of un-germinated Cowpea seeds was 34.44 mg/100 g of material (Tresina and Mohan, 2011), but the length of germination significantly increased the vitamin C content of CowpeaS-Milk.

e. The best CowpeaS-Milk formula

The selection of the best formula was based on the phenolic content, soluble protein, fiber, and vitamin C of CowpeaS-Milk, determined using the effectiveness index (DeGarmo *et al*., 1984). Variables are sorted by priority and contribution to the importance of each variable, with a relative value of 0 – 1. The weighting for phenolic is given a value of 1, soluble protein 0.9, fiber 0.8, and vitamin C 0.7. The highest productivity value was found in the CowpeaS-Milk formula with 12 hours of germination, which contained phenolic antioxidants of 4.67 mgGAE/100g, soluble protein 33%, fiber 1.28%, and vitamin C 75.8 mg/100 g.

Phenolic compounds are antioxidants that have antibacterial, antiviral, and anti-inflammatory activities (Hossain and Uddin, 2020). Phenolics also work as alpha-amylase and alpha-glucosidase inhibitors which slow down the digestion of carbohydrates, thereby reducing the rise in blood sugar (Asgar, 2013). Polyphenols, especially flavonoids, tannins, and phenolic acids can inhibit glucosidase and amylase enzymes for the digestion of carbohydrates into glucose (Lin *et al*., 2016). In other words, phenolic compounds can control the digestion of carbohydrates. In addition to modulating carbohydrate digestion, phenolics also improve conditions of hyperglycemia, dyslipidemia, and insulin resistance, thereby restoring pancreatic beta-cell function, and reducing oxidative stress. In the long term, phenolic compounds can prevent the development of complications of diabetes, such as cardiovascular disease, neuropathy, nephropathy, and retinopathy. Thus, CowpeaS-Milk with high phenolic content is beneficial for diabetics.

Proteins are polymers of amino acids linked by peptide bonds. The main function of protein is to form new tissue, maintain existing tissue, and as a regulator of metabolic processes. Protein has thermogenic properties, providing a longer feeling of fullness, eliminating the urge to eat again, and suppressing subsequent energy intake, thereby controlling blood sugar levels. Rosenvinge Skov *et al*. (1999) reported that the high-protein diet group produced a longer feeling of fullness than the low-protein diet. Therefore, protein-rich CowpeaS-Milk is suitable for consumption by diabetics.

CowpeaS-Milk also contains dietary fiber (1.28%). One of the health effects of fiber-rich functional food is that it can prevent the development of diabetes and hypercholesterolemia. The nature of fiber can increase digesta viscosity, and inhibit the absorption of sugar and cholesterol (Li *et al*., 2019). Thus, CowpeaS-Milk with its fiber content has the potential to control blood sugar and cholesterol levels, making it suitable for people with diabetes and dyslipidemia.

Vitamin C as an antioxidant helps in reducing the production of free radicals (Christie-David *et al*., 2015). Vitamin C can also increase insulin sensitivity and insulin modulation in the process of non-oxidative glucose metabolism. Vitamin C can help increase the mass of pancreatic beta cells, thereby stimulating the production of more insulin (Utami *et al*., 2015). Therefore, CowpeaS-Milk which is known to be rich in vitamin C is beneficial for people with diabetes mellitus.

Conclusion

The duration of germination increased the levels of phenolic, soluble protein, fiber, and vitamin C of CowpeaS-Milk. The best CowpeaS-Milk formula is made from Cowpeas which are germinated for 12 hours, which contains phenolic antioxidants of 4.67 mgGAE/g, 33% soluble protein, 1.28% dietary fiber, and 75.8 mg/100 g vitamin C. Based on its nutritional content, CowpeaS-Milk is suitable for improving the condition of diabetes mellitus.

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References

Afify, A. E. M. M., El-Beltagi, H.S., Fayed, S.A., & Shalaby, E.A. (2011). Acaricidal activity of different extracts from Syzygium cumini L. Skeels (Pomposia) against Tetranychus urticae Koch. Asian Pacific Journal of Tropical Biomedicine, 1(5), 359–364.

Ashraduzzaman MD, Alam MA, Khatun S, Banu S, Absar N. 2011. *Vigna unguiculata* Linn. Walp. seed oil exhibiting antidiabetic effects in alloxan induced diabetic rats. Malaysian Journal of Pharmaceutical Sciences. 9(1): 13-23.

Asgar, Md. A. 2013. Anti-diabetic potential of phenolic compounds: A Review. *International Journal of Food Properties*. 16(1): 91-103.

Burkard M, Leischner Ch, Lauer UM, Busch Ch, Venturelli S, Frank J. 2017. Dietary flavonoids and modulation of natural killer cells: implications in malignant and viral diseases. Journal of Nutritional Biochemistry 46: 1–12. http://dx.doi.org/10.1016/j.jnutbio.2017.01.006

Bewley JD, Bradford KJ, Hilhorst HWM, Nonogaki H. 2013. Seeds physiology of development. In: Germination and dormancy, 3rd ed. Springer, New York

Christie-David, D.J., Girgis, Ch. M., Gunton, J.E. 2015. Effects of vitamins C and D in type 2 diabetes mellitus. Nutrition and Dietary Supplements, 21. doi:10.2147/nds.s52022

Christman, L.M., Dean, L.L., Bueno Almeida, C., Weissburg, J.R. 2018. Acceptability of peanut skins as a natural antioxidant in flavored coated peanuts. Journal of Food Science, 83(10): 2571-2577.

deGarmo, E.P., Sullivan, W.G. and Candra, C.R. 1984. Engineering Economi, 7th edition, Mc. Millan Publ., Co, Newyork.

Ferdiawan, N., Nurwantoro, D.B. 2019. Pengaruh lama waktu germinasi terhadap sifat fisik dan sifat kimia tepung kacang tolo (*Vignia unguiculata* L.). *Jurnal Teknologi Pangan*. 3(2), 349-354.

Goretti, M., Purwanto, M. 2014. Perbandingan analisa kadar protein terlarut dengan berbagai metode Spektroskopi UV-Visible. Jurnal Ilmiah Sains dan Teknologi. 7(2):64-71.

Gómez-Huelgas, R., Gómez Peralta, F., Rodríguez Mañas, L., Formiga, F., Puig Domingo, M., Mediavilla Bravo, J. J., Ena, J. 2018. Treatment of type 2 diabetes mellitus in elderly patients. Revista Clínica Española (English Edition), 218(2): 74-88. doi:10.1016/j.rceng.2017.12.004.

Hossain, M. Z., Uddin, M. N. 2020. Natural polyphenol engineering field crops based diet to promote innate immunity to combat Covid-19 disease. Agriculture and Allied Science. https://osf.io/preprints/agrixiv/da85c/ [26/7/2021]

Khalid, I. and Elhardallou, S. 2016. Factors that compromise the nutritional value of cowpea fluor and its protein isolates. Food and Nutrition Sciences 7: 112-121. doi: 10.4236/fns.2016.72013.

Khang, D., Dung, T., Elzaawely, A., and Xuan, T. 2016. Phenolic profiles and antioxidant activity of germinated legumes. Foods, 5(4): 27. doi:10.3390/foods5020027

Korompot, A.R.H., Fatimah, F., Wuntu, A.D. 2018. Kandungan serat kasar dari bakasang ikan tuna (*Thunnus* sp.) pada berbagai kadar garam, suhu dan waktu fermentasi. Jurnal Ilmiah Sains, 18(1): 31-34.

Li, L., Pan, M., Pan, S., Li, W., Zhong, Y., Hu, J., & Nie, S. (2019). Effects of insoluble and soluble fibers isolated from barley on blood glucose, serum lipids, liver function and caecal short-chain fatty acids in type 2 diabetic and normal rats. Food and Chemical Toxicology, 110937. doi:10.1016/j.fct.2019.110937

Lin, D., Xiao, M., Zhao, J., Li, Z., Xing, B., Li, X., Chen, S. 2016. An overview of plant phenolic compounds and their importance in human nutrition and management of Type 2 Diabetes. Molecules, 21(10): 1374. doi:10.3390/molecules21101374.

Mardiyanto, T. C., dan Sudarwati, S. 2015. Studi nilai cerna protein susu kecambah kedelai varietas lokal secara *In Vitro*. Prosiding Seminar Nasional Masyarakat Biodiv Indonesia. 1(5): 1256-1264.

Masood, T., Shah, H. U. and Zeb, A. 2014. Effect of sprouting time on proximate composition and ascorbic acid level of mung bean (*Vigna radiate* L.) and chickpea (*cicer arietinum* L.) seeds. The Journal of Animal & Plant Sciences, 24(3): 850-859.

Megat, R M R, Azrina, A, Norhaizan, M E. 2016. Effect of germination on total dietary fibre and total sugar in selected legumes. International Food Research Journal 23(1): 257-261.

Nurjanati, M., Winarsi, H., Dwiyanti, H. 2018. Efek lama perkecambahan terhadap sifat sensori dan kadar protein terlarut susu kecambah kacang merah *(Sukarah)* untuk remaja obesitas. *Jurnal Gizi dan Pangan Soedirman*. 2(2): 27-42.

Orak, H. 2006. Total antioxidant activities, phenolics, anthocyanins, polyphenoloxidase activities in red grape varieties. Food Science and Technology. 9: 117-118.

Rosenvinge Skov, A., Toubro, S., Bülow, J., Krabbe, K., Parving, H.-H., & Astrup, A. (1999). Changes in renal function during weight loss induced by high vs low-protein lowfat diets in overweight subjects. International Journal of Obesity, 23(11), 1170–1177. doi:10.1038/sj.ijo.0801048

Safitri, F. M., Rahmadewi Y. M., Apriyanto M. 2017. Pengaruh variasi bahan susu kacang tolo terhadap sifat kimia dan kadar serat kasar. *Jurnal Teknologi Pertanian.* 6(1): 48-59.

Setyorini dan Yusnawan, 2016. Peningkatan kandungan metabolit sekunder tanaman aneka kacang sebagai respon cekaman biotik. Iptek Tanaman Pangan, 11(2): 167-174

Shah, S.A., A. Zeb, T. Masood, N. Noreen, S. J. Abbas, M. Samiullah, M.A. Alim dan A. Muhammad. 2011. Effect of sprouting time on biochemical and nutritional qualities of mung bean varieties. Afr. J. Agril. Res. 6(22): 5091-5098.

Sudarmadji, S., Haryono, B., dan Suhardi. 1997. Analisa Untuk Bahan Makanan dan Pertanian. Bandung: Angkasa.

Thangadurai, D. 2005. Chemical composition and nutritional potential of *Vigna unguiculata SSP. cylindrica (FABACEAE). Journal of Food Biochemistry*, 29(1): 88-98. doi:10.1111/j.1745-4514.2005.00014.x

Tresina, P. S., & Mohan, V. R. 2011. Effect of gamma irradiation on physicochemical properties, proximate composition, vitamins and anti-nutritional factors of the tribal pulse *Vigna unguiculata* subsp. International Journal of Food Science & Technology, 46(8), 1739–1746. doi:10.1111/j.1365-2621.2011.02678.x

Utami, B.S., Bintanah S., Isworo J. T. 2015. Hubungan konsumsi bahan makanan sumber vitamin C dan vitamin E dengan kadar gula darah penderita diabetes mellitus tipe 2 rawat jalan di rumah sakit Tugurejo Semarang. *Jurnal Gizi.* 4(1): 18-23.

Wea, Y. A. S., Wiodo, R. Pratomo, Y. A. 2014. Evaluasi kualitas produk susu kecambah kacang hijau, kajian dari umur kecambah dan kosentrasi Na-CMC. *Jurnal Teknik Industri Heuristic*. 11(1): 61-79.

Weththasinghe P, Liyanage R, Vidanarachchi J, Perera O, Jayawardana B. 2014. Hypocholesteolemic and hypoglycemic effect of cowpea (*Vigna Unguiculata* (L) Walp) incorporated experimental diets in Wistar rats (*Rattus Norvegcus*). Agriculture and Agricultural Science Procedia. 2: 401-405.

Winarsi, H., Erminawati, E., Andreas, A. and Nuraeni, I. 2021. Mung bean sprouts yogurt rich in antioxidants as a functional drink during pandemic. FR-2021-176 [accepted]

Winarsi H, Sasongko ND, Purwanto A. 2016. Germinated-soy milk in supressing inflammation and oxidative stress in blood plasma and breast milk of lactating mothers. International Food Research Journal 23(2): 646-652.

Winarsi H, Septiana AT, Wulandari SP. 2020. Germination improves sensory, phenolic, protein content and anti-inflammatory properties of red kidney bean (*Phaseolus vulgaris* L.) sprouts milk. Food Research 4(6): 1921-1928. https://doi.org/10.26656/fr.2017.4(6).188

Zhou, T., Wang, P., Gu, Z., Ma, M., Yang, R. 2019. Spermidine improves antioxidant activity and energy metabolism in mung bean sprouts. *Food Chemistry. 125759.* doi:10.1016/j.foodchem.2019.125759.

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SURAT TUGAS

Nomor : 781/UN23.13/DL.17/2021

Berdasarkan Surat permohonan dari Prof. Dr. Ir Hery Winarsi, MS perihal permohonan Surat Tugas sebagai Penyaji, maka Dekan Fakultas Ilmu-ilmu Kesehatan Universitas Jenderal Soedirman memberikan tugas kepada :

No	Nama	NIP	Pangkat/Gol
1	Prof. Dr. Ir Hery Winarsi, MS	195703011985032001	Pembina Utama Muda (IVc)
2	Dra. Erminawati, M.Sc, Ph.D	195702151981112001	Pembina (IV/a)
3	Gumintang Ratna Ramadhan, S.TP., M.Si.	198905032019032016	Penata Muda/IIIb
4	Elsya M Gumelar	-	-
5	Lavia ASS Kencana	-	-

untuk menjadi Penyaji pada kegiatan Seminar International Symposium On Food And Agro-Biodiversity (ISFA) 2021 di Semarang tanggal 15 September 2021

Surat tugas ini dibuat untuk dapat digunakan sebagaimana mestinya.

Purwokerto, 14 September 2021

Dekan,

Prof. Dr. Saryono, S.Kp, M.Kes

NIP. 197612102002121001

CERTIFICATE

No. 5793/UN7.5.5.2/TU/2021.

Hereby proudly presented to

Prof. Dr. Ir. Hery Winarsi, MS

as a presenter in the 3rd International Symposium on Food and Agro-biodiversity (the 3rd ISFA) on 14-15 September 2021

Professor Bambang Waluyo Hadi Eko Prasetiyono

Faculty Dean of Animal and Agricultural Sciences
Universitas Diponegoro

Dr Setya Budi Muhammad Abduh

Chairperson of ISFA 2021