

Effect of inulin addition on the proximate content of the low glycemic index of growol cookies

Pengaruh penambahan inulin terhadap kadar proksimat pada modifikasi cookies growol rendah indeks glikemik

Puspita Mardika Sari^{1*}, Desty Eryra Puspaningtyas¹, Silvia Dewi Styaningrum¹, Anita Nidyarini², Tirza Frely Anita¹

¹Nutrition Program, Faculty of Health Sciences, Universitas Respati Yogyakarta

²Nutrition Laboratory, Faculty of Health Sciences, Universitas Respati Yogyakarta

Diterima: 23/05/2023

Ditelaah: 12/07/2023

Dimuat: 28/08/2023

Abstract

Background: Growol is traditional fermented cassava that potentially developed as a snack for diabetic patients. A previous study found that modification of growol cookies with the addition of inulin decreased glycemic index and glycemic load. However, the information nutritional content of this modification was not known yet. **Purpose:** This study examined the effect of addition inulin on the proximate content of growol cookies. **Method:** Observational laboratory of three formulas consists of addition with 5-grams inulin (A); 10-grams inulin (B); and control/ without inulin (C). The nutrition content of growol cookies was analyzed by proximate analysis, consisting of water and ash (thermogravimetry); protein (Kjeldahl); fat (Soxhlet); and carbohydrate (by difference). Data were analyzed using SPSS software with ANOVA followed by LSD for ash, protein, and carbohydrate, while fat and water content were using Kruskal Wallis. **Results:** There were significant differences in proximate content between the control group (growol cookies) and its modification (growol cookies with inulin addition) ($p < 0,001$). Modification of growol cookies with inulin addition significantly decrease calorie ($p < 0,001$) and fat ($p = 0,001$) content, as well as increased protein content ($p < 0,001$). **Conclusion:** The addition of inulin decreased calorie and fat content, and also increased water, ash, protein, and carbohydrate content. Development and evaluation in scale-up production were needed to fulfill the requirement for SNI standards of cookies.

Keywords: cookies; glycemic index; growol; proximate

Abstrak

Latar Belakang: Growol merupakan makanan tradisional dari fermentasi singkong yang berpotensi untuk dikembangkan sebagai makanan selingan bagi pasien diabetes melitus. Modifikasi dengan penambahan inulin pada cookies growol terbukti memberikan efek menguntungkan, yaitu memberikan nilai indeks glikemik dan beban glikemik yang rendah. Namun demikian, informasi nilai gizi (kadar proksimat) dari modifikasi cookies growol belum diketahui. **Tujuan:** Mengetahui pengaruh penambahan inulin terhadap kadar proksimat cookies growol modifikasi. **Metode:** Penelitian *observational laboratory* terdiri atas tiga kelompok perlakuan, yaitu penambahan 5 gram inulin (A), penambahan 10 gram inulin (B), dan kontrol/tanpa penambahan inulin (C). Kandungan gizi cookies growol modifikasi ditentukan dengan analisis kadar proksimat meliputi kadar air dan abu (*thermogravimetri*), protein (*Kjeldahl*), lemak (*Soxhlet*), dan karbohidrat (*by difference*). Analisis data menggunakan *software* statistik (SPSS) dengan uji *Anova* dilanjutkan dengan uji *LSD* untuk kadar abu, protein, dan karbohidrat, serta *Kruskal Wallis* untuk kadar air dan lemak. **Hasil:** Terdapat perbedaan kadar proksimat yang signifikan antara formula cookies growol modifikasi dengan cookies kontrol ($p < 0,001$). Modifikasi cookies growol dengan penambahan inulin berpotensi menurunkan nilai kalori ($p < 0,001$), dan lemak ($p = 0,001$) serta meningkatkan kadar protein ($p < 0,001$) secara signifikan. **Kesimpulan:** Penambahan inulin berpengaruh terhadap penurunan nilai kalori dan lemak, serta meningkatkan kadar protein cookies growol. Diperlukan pengembangan proses *scale up* produksi lebih lanjut untuk memenuhi persyaratan kadar air dan abu sesuai standar SNI cookies.

Kata kunci: cookies; growol; indeks glikemik; proksimat

***Corresponding author:** Puspita Mardika Sari, Nutrition Program, Faculty of Health Sciences, Universitas Respati Yogyakarta, Jl Raya Tajem Km. 1,5 Maguwoharjo, Depok, Sleman, Yogyakarta,
Telp. (0274) 4437888, email: puspitamardika@respati.ac.id; puspitamardika2@gmail.com

BACKGROUND

Growol is Yogyakarta's traditional fermented food made from the spontaneous fermentation of cassava (*Manihot esculenta* Crantz). The previous study found that *growol* had the potential to be developed as a functional food. It was potentially a source of dietary fiber and prebiotics. Fermentation processed of cassava into *growol* was proven to decrease total sugar, reducing sugar, and sucrose content, and also increase carbohydrate content mainly soluble, insoluble, and total dietary fiber (1). *Growol* flour also had a positive prebiotic activity score which indicates that it potentially developed as a source of prebiotics (2).

Previous study also found that *growol* was potentially developed as a snack product for diabetic patients. Food processing of *growol* into cookies product was proven to have a lower glycemic index than the control. However, a score of glycemic index still achieved 87, which is still categorized as food with a high glycemic index (3). Modification of *growol* cookies was done by addition with inulin as dietary fiber into the formula of *growol* cookies. A previous study found that the addition of 10-grams inulin into the *growol* cookies formula contributes to a decreased value of the glycemic index (GI) with a score of 41, and also decrease glycemic load (GL) with a score of 9,33 for 40 grams (5 pieces) of serving size (4). By a study on strategies for blood glucose control in diabetic patients, consumption of food with low GI and GL also high in dietary fiber contributes to the control of post-prandial blood glucose (5). Previous study also found that the addition of 5 and 10 grams of inulin into the *growol* cookies formula was not significantly affected sensory acceptability (6). However, the

effect of its addition to proximate content was not studied yet.

The purpose of this research was to evaluate the effect of 5 grams and 10 grams of inulin addition on the proximate content of *growol* cookies modification. It was observational laboratory research to examine whether there are significant differences in proximate content among 5-grams, and 10-grams inulin addition and control of *growol* cookies. The best inulin addition formula was chosen based on SNI 2011 as the gold standard quality of cookies. The results of this study will contribute to the downstream process for developing *growol* cookies as functional snack products for diabetic patients. Studies on proximate content also contributed as basic data for serving suggestions and nutrition fact information on the product packaging (7).

METHODS

It was an observational laboratory study on proximate content, consisting of water, ash, protein, fat, and carbohydrate. Proximate examinations were done for three groups, consisting of control (*growol* cookies), and its modification consist of 5 grams and 10 grams of inulin addition. Each group was done for three repetitions sample and two unit analyses for each sample (Duplo). The design of this research was served in **Table 1**, while the research stage was served in **Figure 1**.

The study was done from March until November 2022. Formulation of *growol* cookies was done at Culinary and Dietetics Laboratory of Universitas Respati Yogyakarta. Proximate analysis were done at Food and Nutrition Chemistry Laboratory of Agriculture Technology, Universitas Gadjah Mada.

Table 1. Study design on proximate analysis of growol cookies

Unit of analysis	Sample	Formula A	Formula B	Formula C
1	1	AP1	BP1	CP1
	2	AP2	BP2	CP2
	3	AP3	BP3	CP3

Information:

A: formula of growol cookies modification with 5-grams inulin addition

B: formula of growol cookies modification with 10-grams inulin addition

C: formula of growol cookies control

P: proximate content of growol *cookies* (water, ash, protein, fat, carbohydrate)

The study was started with the production of growol flour, made from traditional growol from a local farmer in Kulonprogo, Yogyakarta. The production procedure of growol flour was done based on previous study (6,4). Growol was cut into chip form (± 1 mm) and then dried in a cabinet dryer at 60°C for 24 hours (overnight). Growol chip then grind and sifted until 60 mesh of flour.

Formulation of growol cookies adopted from a previous study (6). The

formula of growol cookies consist of three groups: the addition of 5 grams of inulin (Orafti®) (Formula A), 10 grams of inulin (Formula B), and control (Formula C) without inulin addition. The proximate analysis consists of water and ash content by thermogravimetry methods (8), protein content by using Kjeldahl method, and fat content by using Soxhlet (9), also carbohydrate content using by difference method (10).

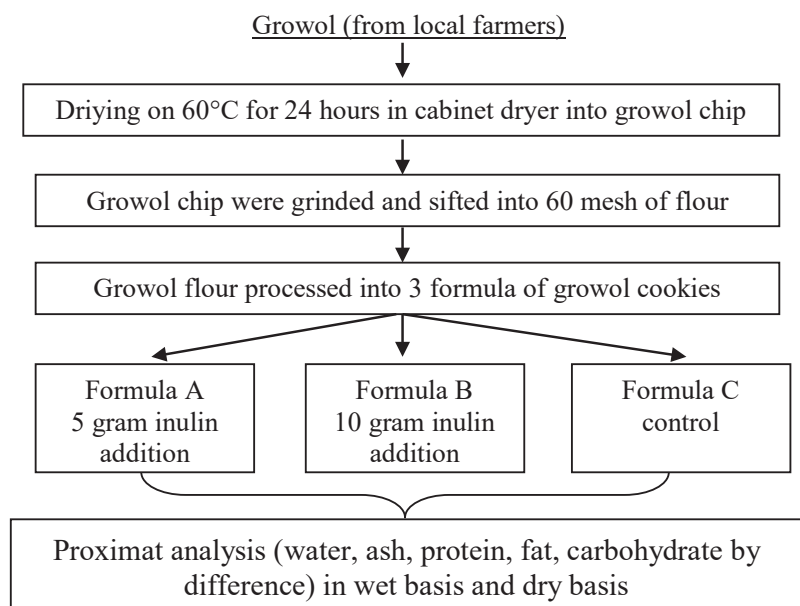


Figure 1. The research design of proximate content on growol cookies modified with inulin addition

The normality of data was analyzed by using Shapiro-Wilk test. Water, protein, and carbohydrate content were categorized as a normal distribution ($p>0,05$), therefore comparative analysis was calculated using ANOVA continued by LSD test. Meanwhile, data distribution of fat and ash content was not normal ($p<0,05$), then comparative analyses were calculated using Kruskal Wallis (non-parametric test).

RESULTS

The proximate content of growol cookies was served on a wet basis and dry basis (**Table 2**), while the nutritional content of growol cookies was served in **Table 3**. This study found that there were significant differences in water, ash, protein, fat, and calories between growol cookies control and its modification with inulin addition. **Table 4** shows the nutritional fulfillment of growol cookies as a snack.

Table 2. Proximate content of growol cookies on a wet basis and dry basis

Group	Water (%)	Proximate analyses							
		Ash (%)		Fat (%)		Protein (%)		Carbohydrate (%)	
		wb	db	wb	db	wb	db	wb	db
A	6,44 (6,25–6,52)	2,79± 0,106 ^a	2,98± 0,111 ^a	28,85 (28,38–29,29)	30,84 (30,27–31,3)	8,63± 0,126 ^a	9,22± 0,128 ^a	53,30± 0,369 ^a	56,96± 0,378 ^a
B	6,39 (6,2–6,58)	2,38± 0,089 ^b	2,54± 0,092 ^b	27,92 (27,44–28,47)	29,82 (29,3–30,35)	8,15± 0,068 ^b	8,70± 0,073 ^b	55,18± 0,257 ^b	58,95± 0,337 ^b
C	5,84 (5,68–6,05)	2,44± 0,093 ^b	2,59± 0,101 ^b	30,30 (29,92–30,45)	32,18 (31,81–32,33)	8,27± 0,170 ^b	8,78± 0,170 ^b	53,16± 0,176 ^a	56,46± 0,240 ^a
		$p=0,003^*$	$p<0,001^{**}$	$p<0,001^{**}$	$p=0,001^*$	$p=0,001^*$	$p<0,001^{**}$	$p<0,001^{**}$	$p<0,001^{**}$

Information:

A: formula of growol cookies modification with 5-grams inulin addition

B: formula of growol cookies modification with 10-grams inulin addition

C: formula of growol cookies control

*: data analyzed by using the Kruskal Wallis test.

** : data analyzed by using the ANOVA test continued with Least Significant Differences (LSD)

Table 3. Nutrition content of growol cookies per serving (40 grams)

Groups	Calories (kcal)		Ash (gram)	Protein (gram)	Fat (gram)	Carbohydrate (gram)
	Per 100 gram	Per serving				
A	489,80±2,04 ^a	195,92	1,11	3,45	11,54	21,32
B	487,34±2,61 ^a	194,94	0,95	3,26	11,17	22,07
C	501,46±1,37 ^b	200,58	0,98	3,31	12,12	21,27
$p<0,001^{**}$						

Information:

A: formula of growol cookies modification with 5-gram inulin addition

B: formula of growol cookies modification with 10-gram inulin addition

C: formula of growol cookies control

** : data analyzed by using the ANOVA test continued with the Least Significant Differences (LSD)

Table 4. Nutrition fulfillment of growol cookies as a snack

Recommended Dietary Allowance based on AKG 2019		Suggestion for snack/ day	Calories of growol cookies per serving			% fulfillment (compared to snack suggestion)		
			20%	A	B	C	A	B
Energy (kcal)	2150	430	195,92	194,94	200,58	45,56	45,33	46,64
Protein (gram)	65	13	3,45	3,26	3,31	26,53	25,07	25,46
Fat (gram)	60	12	11,54	11,17	12,12	96,16	93,08	101
Carbohydrate (gram)	340	68	21,32	22,07	21,27	31,35	32,45	31,27

Information: Recommended Dietary Allowance based on AKG 2019 for men 50–64 years old (2150 kcal)

DISCUSSION

The water content of growol cookies modification with inulin addition (A and B) was higher than growol cookies control ($p=0,003$). While water content was between 5 and 10 inulin addition of inulin was not statistically different. This result correlates with another study which found that characteristics of inulin increase the porosity of cake/cookies dough (11). However, growol cookies modifications have not yet been eligible with the Indonesian standard product of cookies with a 5% maximum value of water content. Water content affects the shelf life of cookies products. The higher water content will be affected by the vulnerable damage of the cookies product. Therefore standardization of growol cookies production processes mainly in time and temperature of the baking process is needed.

There were significant differences in ash content between the control and modification of growol cookies with inulin addition. However, there were no significant differences between the modification of five and ten grams of inulin addition. This study found that ash content was not meet the requirements by the Indonesian national standard of cookies (1,5 % maximum ash content).

Ash content in flour indicates the purity of raw material mainly flour. The high content of ash indicates that flour is added with hazards including the membrane of grain or other material (12). However, another perspective also found that increasing ash content since the addition of dietary fiber and other functional properties were giving advantage to the rich mineral content. There was a significant correlation between dietary intake and bone mineralization (13). This result is also by another study that solid-state fermentation contributed to enriching the mineral properties of the product (14).

There were significant differences in protein content between control cookies and it's inulin modification of cookies ($p<0,001$). The protein content of cookies is higher since the addition of inulin. Increasing protein content since the addition of inulin might be caused by the protein content of inulin. Another study found that the protein content of inulin from dahlia tubers was 0,95% (15). However, we can not ensure the source of inulin because this research used commercial inulin (Orafti ®) which not mentioned the raw material. However, protein content in five gram of inulin addition (A) were significantly higher than control (C) and 10-grams inulin addition

(B), while there were no significant differences between both control (C) and 10 grams of inulin addition (B). These results also different with previous study which found that 10-grams inulin addition in growol cookies resulted in 7,66% of protein content. These differences may be caused by variations of growol since we used growol made by local farmers. It may be caused on differences in fermentation duration and differences of cassava species. Therefore it is important to the next study should use the specific cassava species and standardized fermentation processes.

The fat content (wet basis and dry basis) of the growol cookies modification groups was lower than the control group. Fat content was decreased along with the addition of 5 grams and 10 grams of inulin. These results were similar to the previous study in that growol cookies had lower fat content than wheat cookies (3). Similar results were also found in the other study that the addition of inulin in growol cookies had lower fat content (4). Lower fat content had advantages for the shelf life of products with lower rancidity risk (16). The low-fat content of growol cookies and its modifications also correlated with the low-fat content of these ingredients inulin and growol flour (17).

There were significant differences in carbohydrate content between growol cookies with 10 grams of inulin addition (B) and control (C). However, there were no significant differences in carbohydrate content between growol cookies with 5 grams (A) and control (C). The carbohydrate content of the growol cookies modification was higher than the control may be caused by the addition of inulin into the formula of growol cookies. Inulin is a kind of dietary fiber in the form of soluble indigestible fructose polymer. It was fermentable, bifidogenic, and laxative.

Although total carbohydrates were increased in growol cookies modification, inulin had reported effects on postprandial blood glucose and fasting cholesterol levels have been modest (18). Even, it decreased the glycemic index of growol cookies (4). Another study found a similar potency of inulin for diabetic patients. Inulin supplementation may improve some glycemic and antioxidant indices and decrease malondialdehyde levels in women with type 2 diabetes (19). It gives many advantages in the regulation of blood glucose in diabetic patients (20). Inulin also gives many functional properties such as regulation of gut microbiota in the colon, that affected insulin metabolism (21–23). The positive effects have been observed with several dietary fiber supplements, including inulin-type fructans which produce varying amounts of SCFAs in the gut owing to the complex interaction between the physicochemical properties of the substrate and the gut microbiota. SCFAs have been suggested to improve insulin sensitivity via effects on metabolic pathways and receptor-mediated mechanisms at various tissue and organ sites (24). Calories of growol cookies modification (A and B) were significantly lower than control (C). While calories between five (A) and ten (B) gram inulin addition of growol cookies modification were not significantly different. The decrease in calories may be caused by increasing in carbohydrate complex in growol cookies modification due to inulin addition (1). Information on calories and proximate content contributed to the evaluation of serving suggestions. Growol cookies are suggested as a snack for diabetic patients. Based on a previous study, the maximum serving for a day was 40 grams (5 chips) (4). Based on the Recommended Dietary Allowance (RDA)

calculation, fulfillment of growol cookies per serving was approximately 45% calorie, protein 25-26%, fat 93-96%, and carbohydrate 31-32% if compared with snack suggestion (maximum 20% of total energy each day) (**Table 4**). Therefore it is recommended to combine growol cookies with another kind of snack as a source of calories and protein such as fruits or fruit juice without sugar added (25) and egg white(26).

CONCLUSION AND RECCOMENDATION

Based on this study we found that modification of growol cookies with inulin addition increased water, ash, protein, and carbohydrate content, and also decreased the fat, and calories of growol cookies. However, high content of water increases the risk of vulnerable damage to cookies product. Standardization of growol cookies production processes mainly in time and temperature of the baking process is needed to fulfill water content based on Indonesian standard products of cookies. Further research was needed to develop growol cookies modification (with ten grams of inulin addition) as a snack for diabetic patients. However, based on energy and proximate content calculation per serving of growol cookies, it was recommended to consume a maximum of 40 grams per day or serving. It is also recommended to combine with another snack such as fruits as a source of calories and carbohydrate complex and a source of protein to fulfill the RDA.

ACKNOWLEDGMENT

This research was funded by Grant of Penelitian Dosen Pemula Kemenristekdikti 2022 with contract number: 09/PDP/Kemdikbud/PPPM/UNRIYO/VII/2022

REFERENCES

1. Puspaningtyas DE, Sari PM, Kusuma NH, Helsius SBD. Analisis potensi prebiotik growol: Kajian berdasarkan perubahan karbohidrat pangan. *Gizi Indones*. 2019;42(2):83.
2. Sari PM, Puspaningtyas DE. Skor aktivitas prebiotik growol (makanan fermentasi tradisional dari singkong) terhadap *Lactobacillus* sp. dan *Escherichia coli*. *Ilmu Gizi Indones*. 2019;02(02):101–6.
3. Puspaningtyas DE, Sari PM, Kusuma NH, Helsius SB D. Indeks glikemik cookies growol: studi pengembangan produk makanan selingan bagi penyandang diabetes mellitus. *J Gizi Klin Indones*. 2020;17(1):34.
4. Puspaningtyas DE, Nekada CD, Sari PM. Penambahan inulin terhadap indeks glikemik dan beban glikemik cookies growol: pengembangan makanan selingan diabetes. *AcTion Aceh Nutr J*. 2022;7(2):169–78.
5. Vlachos D, Malisova S, Lindberg FA, Karaniki G. Glycemic index (GI) or glycemic load (GL) and dietary interventions for optimizing postprandial hyperglycemia in patients with t2 diabetes: a review. *Nutrients*. 2020 May 27;12(6):1561. doi: 10.3390/nu12061561.
6. Puspaningtyas DE, Nekada CDY, Sari PM. Analisis sensori dan kadar serat pangan cookies growol dengan penambahan inulin sensory analysis and dietary fiber levels of growol cookies with additional inulin. 2022;5(1):36–42.
7. Rekha G, Rose AL. Proximate nutritional analysis of dried watermelon seed. *Int J Eng Res Gen Sci*. 2016;4(6):44–6.
8. Helrich K. Official methods of analysis. Chemists, Assosiation of Official Analytical. 1999. 312 p.
9. Codex Alimentarius Onternational Food. Recommended methods of analysis and sampling. 2021. 86 p.
10. McCleary B V., McLoughlin C. Measurement of available carbohydrates in cereal and cereal products, dairy products, vegetables, fruit, and related food products and animal

- feeds: First action 2020.07. J AOAC Int. 2021;104(6):1465–78.
11. Ermosh LG, Safronova TN, Prishina N V. Features of biotechnological processes of bread production enriched with inulin-containing raw materials. IOP Conf Ser Earth Environ Sci. 2020;421(2).
12. Emawaningtyas E, Yulinar AW. Uji mutu cookies dengan bahan tambahan tepung kulit pisang raja (*Musa sapientum*) meliputi uji organoleptik, protein, karbohidrat, kadar air, kadar abu. MEDFARM J Farm dan Kesehat. 2019;8(2):32–7.
13. Lee T, Suh HS. Associations between dietary fiber intake and bone mineral density in adult Korean population: Analysis of national health and nutrition examination survey in 2011. J Bone Metab. 2019;26(3):151–60.
14. Dhull SB, Punia S, Kidwai MK, Kaur M, Chawla P, Purewal SS, et al. Solid-state fermentation of lentil (*Lens culinaris* L.) with *Aspergillus awamori*: Effect on phenolic compounds, mineral content, and their bioavailability. Legum Sci. 2020;2(3):1–12.
15. Harahap AO. Mutu fisik dan mutu kimia cookies tepung kacang merah (*Phaseolus vulgaris*) dan tepung bit sebagai pangan fungsional. Skripsi. Politeknik Kesehatan Medan; 2019.
16. Nuraini V, Widanti YA. Pendugaan umur simpan makanan tradisional berbahan dasar beras dengan metode accelerated shelf-life testing (ASLT) melalui pendekatan arrhenius dan kadar air kritis. J Agroteknologi. 2020;14(02):189.
17. Purwandani L. Karakteristik sifat fisik, kimia, dan fisiko-kimia tepung serat bengkung (*Pachyrhizus erosus*) serta potensinya sebagai prebiotik. Universitas Gadjah Mada; 2011.
18. Raninen K, Lappi J, Mykkänen H, Poutanen K. Dietary fiber type reflects physiological functionality: Comparison of grain fiber, inulin, and polydextrose. Nutr Rev. 2011;69(1):9–21.
19. Gargari BP, Dehghan P, Aliasgharzadeh A, Jafar-Abadi MA. Effects of high performance inulin supplementation on glycemic control and antioxidant status in women with type 2 diabetes. Diabetes Metab J. 2013;37(2):140–8.
20. Post RE, Mainous AG, King DE, Simpson KN. Dietary fiber for the treatment of type 2 diabetes mellitus: a meta-analysis. J Am Board Fam Med. 2012;25(1).
21. Duncan A, Holtrop G, Louis P. Effect of inulin on the human gut microbiota. Stimulation of *Bifidobacterium adolescentis* and *Fecalibacterium prausnitzii*. Br J Nutr. 2008;101 (April 2014):541–50.
22. Hoffman JD, Yanckello LM, Chlipala G, Hammond TC, McCulloch D, Parikh I, et al. Dietary inulin alters the gut microbiome, enhances systemic metabolism, and reduces neuroinflammation in an APOE4 mouse model. PLoS One. 2019;14(8):1–22.
23. Guarner F. Inulin and oligofructose: impact on intestinal diseases and disorders. Br J Nutr. 2005;93:61–5.
24. Chambers ES, Byrne CS, Morrison DJ, Murphy KG, Preston T, Tedford C, et al. Dietary supplementation with inulin-propionate ester or inulin improves insulin sensitivity in adults with overweight and obesity with distinct effects on the gut microbiota, plasma metabolome, and systemic inflammatory responses: a randomised cross-over trial. Gut. 2019;68(8):1430–8.
25. Monteiro-Alfredo T, Caramelo B, Arbeláez D, Amaro A, Barra C, Silva D, et al. Distinct impact of natural sugars from fruit juices and added sugars on caloric intake, body weight, glycaemia, oxidative stress and glycation in diabetic rats. Nutrients. 2021;13(9).
26. Jalili-Firoozinezhad S, Filippi M, Mohabatpour F, Letourneur D, Scherberich A. Chicken egg white: Hatching of a new old biomaterial. Mater Today [Internet]. The Author(s); 2020;40(November):193–214. Available from: <https://doi.org/10.1016/j.mattod.2020.05.022>