https://doi.org/10.17221/145/2020-CJFS

Production of low protein and gluten-free cookies for phenylketonuria (PKU) and/or celiac patients

*Ozen Parlak, Ayse Neslihan Dundar**

Department of Food Engineering, Faculty of Engineering and Natural Sciences, Bursa Technical University, Turkey

**Corresponding author: ayse.dundar@btu.edu.tr*

Citation: Parlak O., Dundar A.N. (2021): Production of low protein and gluten-free cookies for phenylketonuria (PKU) and/or celiac patients. Czech J. of Food Sci., 39: 29–34.

Abstract: The aim of this study was to analyse the production of gluten-free, low protein cookies, which can easily be consumed by celiac and phenylketonuria (PKU) patients. The formula was adopted to prepare the control cookies (without dried fruits) from maise starch, stabilisers, salt, sodium bicarbonate, protein-reduced milk powder, and sunflower oil. Different cookies were made by adding raisins (R), dried black currants (Cu), dried dates (D), dried apples and cinnamon (A) separately. In cookies, two different stabilisers were calculated according to starch weight [pectin (P): 0.15%, glycerol monostearate (GMS, G): 0.4%]. The effects of stabilisers and dried fruits on the physicochemical and sensory properties of cookies were investigated. The protein content was significantly higher ($P < 0.05$) in the cookies including R with pectin (PR), Cu with pectin (PCu), and A with pectin (PA). The amount of phenylalanine (Phe) was significantly higher ($P < 0.05$) in PR. The values of dietary fibre were the highest in the A cookies, while the lowest values appeared in the control (C). In the sensory evaluation (appearance, tasting properties, and affordability), it was found that PD (pectin with dries dates) was chosen as the best cookie ($P < 0.05$).

Keywords: celiac disease; cookie; dried fruits; stabiliser

Phenylketonuria (PKU) is a hereditary disease caused by a genetic mutation. This mutation results in the absence or inadequacy of the enzyme that hydrolyses Phe (phenylalanine). It leads to an increase in the amount of calcein Phe and inhibits the absorption of important amino acids that should be taken to cross the brain-blood barrier, leading to intellectual retardation or mental disorders (Neyzi and Ertugrul 2002; Bélanger-Quintana et al. 2011).

In the treatment of PKU, normal development and social initiation of children with PKU can be achieved through the application of a special diet (low-protein diet) with restricted Phe (Seckin 2007). It should be started after the diagnosis of the disease in the newborn period (Lee and Newman 2003). For PKU patients, major nutrients – including all kinds of red and white meat and their products; eggs; milk and dairy products; hazelnuts; and cereal products as well as foods containing aspartame or products derived from these foods – are not allowed to be consumed. PKU patients can tolerate approximately 500 mg of Phe per day (approximately 10% of the amount in a normal diet) (Ney et al. 2009).

Celiac disease, which is one of the most common food intolerances today, is an allergic reaction of the digestive system against gluten taken from cereal products such as wheat, rye, barley, and triticale. The symptoms of the disease frequently recur and include abdominal distention, abdominal pain, chronic diarrhoea, pale and malodor-

Supported by the Scientific Research Council of Bursa Technical University, Bursa, Turkey (Project No. 172L13).

https://doi.org/10.17221/145/2020-CJFS

ous stools, weight loss, fatigue, cramps in muscles, and growth disorders (Fasano 2003; Lee and Newman 2003). The only treatment of gluten intolerance that irritates the small intestines of patients with celiac disease is to consume gluten-free nutrients throughout their lives. Grains which do not contain gluten in their natural products such as maise and rice are therefore used as raw materials in gluten-free products (Ozkaya 1999).

Although research and development studies for celiac disease have been conducted in recent years, there are not enough studies for PKU patients yet. Ingredients such as soft wheat flour and milk powder cookies are on the list of prohibited foods of PKU and celiac patients. The objective of this study is to get a new alternative gluten-free cookie formulation so that this product would easily be consumed as ready-to-eat food with a high energy value and would also be preferred by people of all ages, especially by PKU and celiac patients.

MATERIAL AND METHODS

Material. In the cookie production maise starch, stabilisers, salt, sodium bicarbonate, dried apple, raisins, dried black currants, dried dates, and cinnamon, protein-reduced milk powder, and sunflower oil were used. All ingredients were purchased from local markets.

Preparation of cookies. Cookies were prepared according to AACC method 10-54.01. Two different formulations were used for production. Pectin (P) and glycerol monostearate (GMS) were used as stabilisers. Cookies produced with GMS and pectin were coded with G and P, respectively, and different cookies were produced adding raisins (R), dried black currants (Cu), dried dates (D), and dried apples and cinnamon (A) to these cookies (PR, PCu, PD, PA, GR, GCu, GD, GA). Control cookies were made with no dried fruit addition (PC, GC).

Table 1. Cookie formulation

Components	(g 100 g^{-1})	Components	(g 100g^{-1})
Maize starch	100	P*	0.15
Protein reduced milk powder	1	G*	0.4
Sodium bicarbonate	1.25	Sugar	37
Salt	1.25	Molasses	5
Vegetable oil	20	Dried fruits*	10
Water	40	Cinnamon*	0.4

*It is used according to ingredients [raisins (R), dried black currants (Cu), dried dates (D), and dried apples and cinnamon (A)]; P – cookies produced with pectin; G – cookies produced with glycerol monostearate

Maise starch and other dry samples (except the stabiliser) (sugar, salt, sodium bicarbonate, and milk powder) were mixed in a bowl at the amount shown in Table 1 and transferred to the mixer bowl. In a separate bowl, water, oil, and stabiliser were mixed and added to the mixer bowl. The cookie dough was obtained by mixing for a total of 1 min by cleaning the walls of the bowl with spatula every 15 sec with a mixer (5KSM150PS; KitchenAid, USA). The dough was rolled out by going forward and backward once with a rolling pin and shaped with a round mould. It was baked in the oven (Venarro, PF031VR; Venarro, Turkey) at 180 ± 2 °C for 15 min. The cookies were cooled at room temperature, wrapped in aluminium foil, and kept until analyses.

Composition. The moisture, protein, ash and fat of the cookies were evaluated using methods 44.01, 46.12, 935.38, and 08.01.01, respectively, according to the AACC (2010). The determination of total dietary fibre was obtained by the enzymatic-gravimetric method (Prosky et al. 2018). Amino acid compositions were determined using the HPLC method described by Aristoy and Toldra (1991) and Antoine et al. (1999). The available carbohydrates (CHOs) were calculated as the percentage difference between 100 and the sum of the moisture, protein, lipid, ash, and total dietary fibre amounts. The energy value of the samples was estimated from the coefficients of Atwater (FAO 2003), according to Equation (1):

$$\text{Energy value (kcal)} = (9 \times \text{lipid \%}) + (4 \times \text{protein \%}) + 4 \times (\text{available CHOs \%}) \quad (1)$$

The analyses of the dietary fibre and amino acid compositions were carried out twice, while the other analyses were performed in triplicate.

Physical properties of cookies. According to the AACC method 10-54.01 (AACC 2010), a calliper was used to measure the diameter (*D*) and thickness (*T*) of cookies at room temperature. The spread ratio (*D*/*T*) was calculated according to method 10-50.05 of the AACC (2010).

Minolta spectrophotometer CR-400 (Japan) was used to determine the surface colour of the cookies by the CIE colour scales of L^*, a^*, b^* values. Four cookies were selected randomly to measure the colour, and each cookie was measured three times in different places (Ozboy and Koksel 1999).

A texture analyser (TA Plus; Lloyd Instruments, UK) equipped with a 3-point bending jig with a distance of 40 mm between the edges was used for texture analysis. A load cell of 1 000 N was used. The downward movement did not stop until the cookie broke.

https://doi.org/10.17221/145/2020-CJFS

The maximum force (N) of the cookie was determined 24 h after baking (Ozboy and Koksel 1999).

Sensory evaluation of cookies. The sensory evaluation of the cookies was performed by thirty untrained panellists including eight males and twenty-two females with ages ranging from 18 to 30. Product sensory evaluation was carried out in terms of appearance, tasting properties, and purchase intention based on a nine-point hedonic scale by a score of 1–9 (Meilgaard et al. 2007). The instructions were given in full to panellists beforehand. The cookies were coded with two-digit random numbers and given to panellists in random order.

Statistical analyses. The statistical analysis was done using SPSS 24.0. The data were analysed for variance using the one-way analysis of variance (ANOVA). When significant differences were found ($P < 0.05$), the averages of the major variation sources, which were found to be statistically significant, were compared using the LSD (least significant difference) test.

RESULTS AND DISCUSSION

Since PKU patients can consume only special low protein (SLP) cookies, it would be meaningful to compare the chemical properties of cookies only with these types of cookies in this study. Besides, there are hardly any studies on this subject in the literature.

The control samples had lower moisture content than cookies with dried fruit (Table 2). The highest moisture level was detected in PA ($P < 0.05$). According to the stabilisers, G cookies had lower moisture content than the cookies with P as determined by the paired t-test ($P < 0.05$).

The ash content of P was 1.5% while that of G was 0.15%. Therefore, the ash content of cookies produced with P was higher than that of cookies produced with G containing the same fruit. However, this difference was not significant. The addition of dried fruits had the greatest effect on the ash content. Maise starch and potato starch were the main types of starch used in special low protein foods (SLPFs) (Wood et al. 2020). In this study, maise starch was used as a raw material for PKU patients to consume. Since the ash content of the starch was negligible, the ash content of GC, PC was the lowest. Samples containing Cu and R (dried fruits with the highest ash contents) had the highest ash contents.

Most patients with PKU tolerate < 10 g of natural protein daily (Ford et al. 2018) with up to 80% of daily protein provided by minimal Phe-containing protein substitutes. In this study, we used low protein ingredients in cookie production, and the protein content of the cookies was determined as 0.43–0.74 g. In a study in which the nutritional composition of commercial SLP products was determined, the protein content of SLP cookies was found to be 0.1–0.8 g (Pena et al. 2015). These values were similar to the values in our study. The addition of dried fruits increased the protein content. The lowest protein content was determined in PC, whereas the highest protein contents were determimed in PR, PCu, and PA. When the stabilisers were compared, the highest ($P < 0.05$) protein content was detected in the cookies produced with P ($P < 0.05$).

Table 2. Chemical properties of cookies

Sample	Moisture (%)*	Ash (%)*	Protein (N% × 6.25)*	Lipid (%)*	Phenylalanine* (mg g^{-1})	Dietary fibre (%)*	Available CHO (%)*	Energy (kcal)*
PC	4.63 ± 0.03^{h}	0.64 ± 0.01^{g}	0.43 ± 0.02^{f}	12.07 ± 0.01^{b}	0.019 ± 0.01^{f}	0.6 ± 0.01^{de}	81.61 ± 0.04^{b}	436.79 ± 0.04^{b}
PR	5.33 ± 0.01^{d}	0.95 ± 0.02^{a}	0.74 ± 0.01^{a}	11.64 ± 0.07^{cd}	0.064 ± 0.01^{a}	0.9 ± 0.02^{cd}	80.38 ± 0.05^{e}	429.24 ± 0.04^{e}
PCu	5.42 ± 0.02^{c}	0.95 ± 0.01^{a}	0.74 ± 0.01^{a}	11.54 ± 0.06^{d}	0.045 ± 0.01^{b}	1.0 ± 0.01^{c}	80.31 ± 0.06^{e}	428.06 ± 0.05^{f}
PD	5.83 ± 0.21^{b}	0.86 ± 0.02^{c}	0.65 ± 0.01^{d}	11.54 ± 0.03^{d}	0.036 ± 0.01^{c}	1.0 ± 0.02^{c}	80.08 ± 0.01^{f}	426.78 ± 0.03^{g}
PA	6.06 ± 0.21^{a}	0.82 ± 0.01^{e}	0.74 ± 0.01^{a}	11.85 ± 0.20^{bc}	0.029 ± 0.01^{d}	2.0 ± 0.04^{a}	78.50 ± 0.21^{h}	423.61 ± 0.02^{h}
GC	4.18 ± 0.21^{i}	0.63 ± 0.01^{h}	0.44 ± 0.02^{f}	12.42 ± 0.26^{a}	0.010 ± 0.01^{g}	0.4 ± 0.01^{e}	81.92 ± 0.23^{a}	441.14 ± 0.03^{a}
GR	5.21 ± 0.02^{e}	0.94 ± 0.03^{b}	0.70 ± 0.02^{c}	11.45 ± 0.04^{d}	0.047 ± 0.01^{b}	0.7 ± 0.01^{cde}	80.95 ± 0.01^{d}	429.65 ± 0.36^{e}
GCu	4.69 ± 0.02^{g}	0.94 ± 0.02^{b}	0.70 ± 0.03^{c}	11.63 ± 0.12^{cd}	0.036 ± 0.01^{c}	0.8 ± 0.02^{cd}	81.20 ± 0.07^{c}	432.27 ± 0.03^{c}
GD	5.08 ± 0.01^{f}	0.85 ± 0.01^{d}	0.61 ± 0.01^{e}	11.52 ± 0.12^{d}	0.029 ± 0.01^{d}	0.8 ± 0.01^{cd}	81.11 ± 0.15^{d}	430.56 ± 0.07^{d}
GA	5.34 ± 0.02^{d}	0.81 ± 0.01^{f}	0.72 ± 0.01^{b}	11.66 ± 0.13^{cd}	0.024 ± 0.01^{e}	1.6 ± 0.03^{b}	79.85 ± 0.12^{g}	427.72 ± 0.05^{fg}

*There is a statistically significant difference between the meanings of the different letters in the LSD test ($P < 0.05$); CHO – carbohydrate; PC – control, with pectin (no dried fruit addition); PR – pectin with raisins; PCu – pectin with dried black currants; PD – pectin with dried dates; PA – pectin with apples and cinnamon; GC – control, with glycerol monostearate (G) (no dried fruit addition); GR – G with raisins; GCu – G with dried black currants; GD – G with dried dates; GA – G with apples and cinnamon

https://doi.org/10.17221/145/2020-CJFS

The highest lipid contents were determined in PC and GC and the dried fruit addition decreased the lipid content of the cookies. Pena et al. (2015) detected the lipid content of cookies in the range of 1.5–49.4. The lipid amounts of the cookies in our study were determined to be 11.52–12.42 and these values were in the range of the study of Pena et al. (2015).

The Phe amounts of PC and GC were lower than in the other cookies. This difference came from the addition of dried fruits. When the effect of stabilisers was examined, it was found that P significantly increased the amount of Phe ($P < 0.05$) because of protein contents. In a study, commercial PKU cookies in 9 countries were analysed and Phe amounts of cookies were found to be between 2 and 34 mg (Pena et al. 2015). In another study, a total of 151 foods were collected from the UK and they determined the nutritional composition of these products. In their study, they examined six cookies and found the Phe amount of 1–27 mg (Wood et al. 2020). The Phe contents of cookies in our study were 10–64 mg, and these values were similar to the studies described above. Dobrowolski et. al. (2011) and Saudubray and Walter (2012) emphasised that the daily consumption of Phe in PKU patients was 770 mg in women and 1 200 mg in men. In this study, the amounts of Phe were found much lower than those values.

The dietary fibre contents in the cookies ranged from 0.4% (GC) to 2% (PA). Dietary fibre was significantly ($P < 0.05$) higher in PA and GA while the dietary fibre of PC and GC was lower. The higher amounts of dietary fibre stemmed from the dietary fibre content of A.

The CHO amounts of commercial SLP cookies were found to be 48.3–87.7% (Pena et al. 2015). In this study, the CHO contents (dietary fibre + available CHOs) of the cookies were determined to be 80.50–81.92%, which showed similarity with Pena et al. (2015). The available CHO values of PC and GC were significantly ($P < 0.05$) higher than in the others.

The energy content of all SLPFs is important. Although similar to the general population, overweight is an apprehension in PKU, especially in older women with poor Phe control (Rocha et al. 2013). In cookies, the highest energy value was calculated to be 441.14 kcal (GC), whereas the lowest value was 423.61 kcal (PA). GA and PA had the lowest energy values because of the dietary fibre contents. Pimentel et al. (2014) compared the energy values of low protein foods (sixteen dishes such as soup, pasta, some vegetable patties, biscuit cake, etc. specifically prepared for PKU patients) in their studies and found that energy values in low protein cookies ranged from 442 kcal to 468 kcal. In another study, commercial SLP cookies had 395–639 kcal (Pena et al. 2015). These values are similar to the findings of our study.

Physical properties of cookies. The diameter, spread ratio (SR), hardness, and colour values of the cookies supplemented with dried fruits are presented in Table 3.

PKU patients have to consume SLP cookies. We could not find any studies on the physical properties of cookies specially produced for these patients. Therefore, we compared the cookies with those for celiac patients.

SR and diameter values are important quality parameters in cookies. It is generally desired that the diameter is wide and the SR value is high (Barak et al. 2013). In our study, the SR values of the cookies supplemented with dried fruits decreased. Higher dietary fibre

Table 3. Physical properties of cookies

Sample	Diameter (cm)*	Spread ratio*	Hardness (N)*	Colour values		
				*L**	*a**	*b**
PC	10.06 ± 0.08^{de}	6.46 ± 0.31^{bc}	25.42 ± 0.28^{d}	47.07 ± 0.02^{c}	7.02 ± 0.01^{bc}	32.14 ± 0.23^{bc}
PR	10.83 ± 0.01^{ab}	6.00 ± 0.06^{cd}	29.97 ± 0.02^{a}	46.86 ± 0.02^{c}	6.64 ± 0.22^{cd}	31.81 ± 0.03^{cd}
PCu	10.22 ± 0.03^{d}	6.45 ± 0.02^{bc}	23.75 ± 0.14^{ef}	47.87 ± 0.85^{b}	6.88 ± 0.06^{c}	31.23 ± 0.95^{d}
PD	10.33 ± 0.04^{cd}	6.22 ± 0.50^{bcd}	28.54 ± 0.71^{b}	50.12 ± 0.11^{a}	6.52 ± 0.08^{d}	34.25 ± 0.17^{a}
PA	10.90 ± 0.23^{a}	5.85 ± 0.01^{d}	30.72 ± 0.16^{a}	46.46 ± 0.27^{cd}	7.60 ± 0.25^{a}	32.32 ± 0.08^{bc}
GC	10.05 ± 0.02^{e}	7.17 ± 0.15^{a}	24.74 ± 0.09^{de}	49.83 ± 0.23^{a}	6.39 ± 0.12^{d}	31.74 ± 0.59^{cd}
GR	10.47 ± 0.51^{bcd}	6.57 ± 0.07^{b}	23.26 ± 0.27^{f}	49.62 ± 0.13^{a}	6.63 ± 0.09^{c}	32.76 ± 0.13^{b}
GCu	10.20 ± 0.01^{e}	6.48 ± 0.12^{b}	24.03 ± 0.82^{ef}	46.05 ± 0.27^{d}	7.27 ± 0.11^{b}	32.63 ± 0.24^{bc}
GD	10.76 ± 0.16^{ab}	6.25 ± 0.20^{bcd}	26.03 ± 1.22^{d}	46.75 ± 0.14^{c}	7.60 ± 0.14^{a}	34.44 ± 0.08^{a}
GA	10.73 ± 0.28^{abc}	5.92 ± 0.12^{d}	28.51 ± 0.50^{c}	46.41 ± 0.13^{cd}	7.30 ± 0.03^{b}	31.29 ± 0.20^{d}

*There is a statistically significant difference between the meanings of the different letters in the LSD test ($P < 0.05$); for abbreviations see Table 2

https://doi.org/10.17221/145/2020-CJFS

of dried fruits was conceivably responsible for the reduction in the SR of PKU cookies. In PA and GA, which had the highest dietary fibre, the significantly ($P < 0.05$) lowest SR (5.85) was detected. It is thought that dried apples-rich dietary fibre reduced the amount of unabsorbed free water, which may lead to an increase in viscosity and a decrease in SR.

When the hardness of cookies was examined, the cookies with D (28.54 N, 26.03 N), A (30.72 N, 28.51 N) had higher values than the GC, PC (25.42 N, 24.74 N). Pineli et. al. (2015) and Ajila et al. (2008) reported that fibre content is effective on the hardness of cookies. The findings of our study show the same trend as the literature, the higher dietary fibre content of D and A provided an increase in the hardness of cookie texture. Furthermore, the hardness values of the cookies which were produced with P were higher than those of cookies produced with G, because of higher fibre content. Simas et al. (2009) produced cookies by adding a mixture of rice starch, maise starch, and palm flour at different ratios and reported that the hardness degrees of cookies were between 5.21 N and 55.29 N. Our values were similar to those of that study.

The colour values of the cookies are given in Table 3. The dried fruits-containing G cookies, compared to GC, were characterised by a darker colour. PD showed higher luminosity (L^*) among all the cookies. Besides, GD and PA showed higher red chromaticity (a^*) among all the cookies. It was found that PD (34.25) and GD (34.44) had significantly higher yellow chromaticity (b^*) ($P < 0.05$). This may have been due to the colour of the D added to the cookies.

Table 4. Sensory properties of cookies

Sample	Appearance*	Taste-flavour*	Affordability/ purchasing*
PC	7.47 ± 0.32^{cd}	7.43 ± 0.21^{cd}	7.27 ± 0.24^{d}
PR	7.50 ± 0.25^{bcd}	7.44 ± 0.43^{c}	7.27 ± 0.16^{d}
PCu	7.50 ± 0.45^{bcd}	7.63 ± 0.27^{b}	7.60 ± 0.32^{c}
PD	7.64 ± 0.34^{a}	7.87 ± 0.52^{a}	8.33 ± 0.24^{a}
PA	7.53 ± 0.45^{b}	7.86 ± 0.24^{a}	7.67 ± 0.36^{b}
GC	7.22 ± 0.12^{f}	6.92 ± 0.15^{g}	6.33 ± 0.17^{h}
GR	7.33 ± 0.56^{e}	7.20 ± 0.27^{f}	6.53 ± 0.27^{g}
GCu	7.31 ± 0.21^{e}	7.27 ± 0.13^{e}	6.80 ± 0.27^{f}
GD	7.52 ± 0.33^{bc}	7.37 ± 0.46^{d}	6.87 ± 0.22^{e}
GA	7.45 ± 0.15^{d}	7.30 ± 0.17^{e}	6.87 ± 0.34^{e}

*There is a statistically significant difference between the meanings of the different letters in the LSD test ($P < 0.05$); for abbreviations see Table 2

Sensory evaluation of cookies. The sensory properties of the cookies prepared with dried fruits are shown in Table 4. The number of consumers participating in the sensory evaluation was 30 panellists, 90% of them were between the ages of 18–25, and the majority were women (73%). PD had the highest appearance scores, whereas GC had the lowest appearance scores. According to taste-flavour, the best liked cookies by the panellists are PD (7.87), and PA (7.86), while the least liked is GC (6.92).

The affordability of PD, which had high appearance and taste-flavour scores, was also high, and this was to be expected. Furthermore, the P cookies gave the higher appearance, taste-flavour, and affordability values than the G cookies as determined by the paired *t*-test ($P < 0.05$).

In the sensory evaluation with the hedonic scale, the scores of 5 and above were considered acceptable. It was found that all the cookies were agreeable and purchasable.

CONCLUSION

This study showed that dried fruits (R, Cu, D, and A) and stabilisers (G and P) used in the cookie formulation significantly affected the characteristics of cookies. Cookie quality was positively affected by the addition of fruits. It was observed that the effect of dried fruits on cookie quality was more pronounced than that of stabilisers. We can briefly explain that the moisture, ash, protein, Phe, dietary fibre, and diameter values of the cookies with dried fruits were increased compared to the control cookies. On the other hand, a decrease was observed in the values of fat, available COH, energy, and SR. Differences were observed in hardness and colour values according to the addition of dried fruit.

Moreover, stabilisers in cookie dough affected moisture, ash, protein, lipid, Phe, dietary fibre, available COH, SR of the cookies, and this effect was at a statistically significant level ($P < 0.05$). In addition to dried fruits of dough, the colour of the cookies became darker, and the L^* colour values decreased. The sensory properties and quality qualifications of the cookies were found to be appropriate. The most favoured cookie was PD. The amount of Phe (< 500 mg Phe), which is particularly important for PKU patients, was found appropriate. Besides the dietary fibre enrichment, all cookies were provided with the quality characteristics and found acceptable according to sensory evaluation.

https://doi.org/10.17221/145/2020-CJFS

REFERENCES

Ajila C.M., Leelavathi K., Prasada Rao U.J.S. (2008): Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. Journal of Cereal Science, 48: 319–326.

Antoine F.R., Wei C.I., Littell R.C., Marshall M.R. (1999): HPLC method for analysis of free amino acids in fish using o-phthaldialdehyde precolumn derivatisation. Journal of Agriculture and Food Chemistry, 47: 5100–5107.

Aristoy M.C., Toldra Õ.F. (1991): Deproteinization techniques for HPLC amino acid analysis in fresh pork muscle and dry cured ham. Journal of Agricultural and Food Chemistry, 39: 1792–1795.

Barak S., Mudgil D., Khatkar B.S. (2013): Effect of composition of gluten proteins and dough rheological properties on the cookie-making quality. British Food Journal, 115: 564–574.

Bélanger-Quintana A., Burlina A., Harding C.O., Muntau A.C. (2011): Up to date knowledge on different treatment strategies for phenylketonuria. Molecular Genetics and Metabolism, 104: 19–25.

Dobrowolski S.F., Heintz C., Miller T., Ellingson C., Ellingson C., Ozer I., Gökçay G., Baykal T., Thöny B., Demirkol M., Blau N. (2011): Molecular genetics and impact of residual *in vitro* phenylalanine hydroxylase activity on tetrahydrobiopterin responsiveness in Turkish PKU population. Molecular Genetics and Metabolism, 10: 116–121.

FAO (2003): Food and Nutrition Paper 77, Food energy - methods of analysis and conversion factors-Chapter III. Food and Agriculture Organization.

Fasano A. (2003): Celiac disease how to handle a clinical chameleon. New England Journal of Medicine, 348: 2568–2570.

Ford S., O'Driscoll M., MacDonald A. (2018): Living with Phenylketonuria: Lessons from the PKU community. Molecular Genetics and Metabolism Reports, 17: 57–63.

Lee A., Newman J.M. (2003): Celiac diet: Its impact on quality of life. Journal of the American Dietetic Association, 103: 1533–1535.

Meilgaard M., Civile G.V., Carr B.T. (2007). Sensory Evaluation Techniques. 4th Ed. CRC Press. Florida, USA: 1–464.

Ney D.M., Gleason S.T., Calcar S.C., MacLeod E.L., Nelson K.L., Etzel M.R., Rice G.M., Wolff J.A. (2009): Nutritional management of PKU with glycomacropeptide from cheese whey. Journal Inherit Metabolic Disease, 32: 32–39.

Neyzi O., Ertuğrul T. (2002): Pediatri. Nobel Tıp Kitabevi, Istanbul, Turkey: 787–791.

Ozboy O., Koksel H. (1999): Utilization of sugar beet fiber in the production of "high fiber bread". Zuckerindustrie, 124: 712–715.

Ozkaya B. (1999): Allergies caused by cereals and its importance-2. Food Hi-Tech, 3: 82–88.

Pena M.J., Almeida M.F., van Dam E., Ahring K., Bélanger-Quintana A., Dokoupil K. et al. (2015): Special low protein foods for phenylketonuria: Availability in Europe and an examination of their nutritional profile. Orphanet Journal of Rare Diseases: 10.

Pimentel F.B., Alves R.C., Costa A.S.G., Fernandes T.J.R. (2014): Nutritional composition of low protein and phenylalanine-restricted dishes prepared for phenylketonuric patients. Food Science and Technology, 57: 283–289.

Pineli L. de L. de O., de Carvalho M.V., de Aguiar L.A., de Oliveira G.T., Celestino S.M.C., Botelho R.B.A., Chiarello M.D. (2015): Use of baru (Brazilian almond) waste from physical extraction of oil to produce flour and cookies. LWT – Food Science and Technology, 60: 50–55.

Prosky L., Asp N.G., Schweizer T.F., DeVries J.W., Furda I. (1988): Determination of insoluble, soluble, and total dietary fiber in foods and food products: Interlaboratory study. Journal of Association of Official Analytical Chemists, 71: 1017–1023.

Rocha J.C., MacDonald A., Trefz F. (2013): Is overweight an issue in phenylketonuria? Molecular Genetics and Metabolism, 110: 18–24.

Saudubray J.M., Walter J.H. (2012): Hyperphenylalaninaemia. Inborn Metabolic Diseases, Diagnosis and Treatment. Springer Medizin Verlag Heidelberg: 251–264.

Seckin Y. (2007): Psycho-pedagogical problems and solutions of children with phenylketonuria. IX. International Congress on Nutrition and Metabolism, Istanbul, Turkey: 39–43.

Simas K.N., Vieira L.N., Podesta R., Müller C.M. (2009): Effect of king palm (Archontophoenix alexandrae) flour incorporation on physicochemical and textural characteristics of gluten-free cookies. International Journal of Food Science and Technology, 44: 531–538.

Wood G., Evans S., Pointon-Bell K., Rocha J. C., MacDonald A. (2020): Special low protein foods in the UK: An examination of their macronutrient composition in comparison to regular foods. Nutrients, 12: 1893.

Received: June 1, 2020
Accepted: January 19, 2021