Calculating the Protein Quality of Soups Consumed in Türkiye

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Abstract

This study aimed to estimate the protein quality of some soups consumed in Türkiye using the protein digestibility-corrected amino acid score (PDCAAS) method. This method is based on limiting amino acids and digestibility factors. The limiting amino acid in dietary proteins affects amino acid synthesis in the body. Because protein synthesis depends on the minimum amount of amino acids. If PDCAAS is less than 1, the soup has at least one limiting amino acid (LAA). In this study, twenty-five different soups' energy, protein, and essential amino acid patterns were analyzed, and PDCAAS was calculated. Microsoft Excel Programme was used to calculate the data obtained. The soups with the highest protein quality were *Lebeniye* (1.0), *Yogurt* (1.0), *Flour* (0.9), *Tarhana* (0.88), and *Tomato soup milk* (0.87). The soups with the lowest protein quality were *Tutmaç* (0.38), *Rice* (0.46), *Yüzük* (0.61), *Vegetable soup (summer)* (0.62), and *Vegetable soup (winter)* (0.64). *Lebeniye* and *Yogurt soup* had no LAA, whereas *Tarhana, Vegetable soups, Tutmaç, Rice, and Yüzük soup* had lysine LAA. The LAA of tomato soup milk is methionine and cysteine. Animal proteins added to the soup increase the protein quality. Considering that protein quality is as important as protein quantity in providing a healthy diet, this study is thought to be guided when planning nutrition, especially in groups with low protein intake.

Keywords: *Protein quality, PDCAAS, soup.*

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Türkiye'de Tüketilen Çorbaların Protein Kalitesinin Hesaplanması

Öz

Bu çalışmada, Türkiye'de tüketilen bazı çorbaların protein kalitesinin, protein sindirilebilirliği düzeltilmiş amino asit skoru (PDCAAS) yöntemi kullanılarak tahmin edilmesi amaçlanmıştır.Bu yöntem, kısıtlayıcı amino asitlere (KAA) ve sindirilebilirlik faktörlerine dayanmaktadır. Diyet proteinlerindeki kısıtlayıcı amino asit, vücuttaki amino asit sentezini etkiler. Çünkü protein sentezi minimum amino asit miktarına bağlıdır. PDCAAS 1'den küçükse, çorbada en az bir KAA vardır. Bu çalışmada, yirmi beş farklı çorbanın enerji, protein ve esansiyel amino asit örüntüleri analiz edilmiş ve PDCAAS hesaplanmıştır. Elde edilen verilerin hesaplanmasında Microsoft Excel Programı kullanılmıştır. Protein kalitesi en yüksek çorbalar *Lebeniye* (1,0), *Yoğurt* (1,0), *Un* (0,9), *Tarhana* (0,88) ve *Sütlü domates çorbası* (0,87)'dır. Protein kalitesi en düşük olan çorbalar ise *Tutmaç* (0,38), *Pirinç* (0,46), *Yüzük* (0,61), *Sebze çorbası (yaz)* (0,62) ve *Sebze çorbası (kış)* (0,64)'dır. PDCAAS 1'den küçükse çorbada en az bir KAA vardır. *Lebeniye ve Yoğurt* çorbasında KAA yokken, *Tarhana, Sebze çorbaları, Tutmaç, Pirinç ve Yüzük çorbası* için KAA lizindir. *Sütlü domates çorbası*'nda KAA metiyonin ve sisteindir. Çorbaya eklenen hayvansal proteinler protein kalitesini arttırmaktadır. Sağlıklı beslenmenin sağlanmasında protein miktarı kadar protein kalitesinin de önemli olduğu göz önünde bulundurulduğunda, bu çalışmanın özellikle protein alımı düşük olan gruplarda beslenme planlaması yapılırken yol gösterici olacağı düşünülmektedir.

Anahtar kelimeler: *Protein kalitesi, PDCAAS, çorba.*

Introduction

Proteins are macronutrients that play numerous structural and functional roles in the body. Proteins, the primary nitrogen source in the diet, are composed of amino acids linked by peptide bonds (Sá et al., 2020). Approximately 16% of an adult's body is composed of proteins. The Türkiye Dietary Guidelines (2022) set the recommended adequate intake for protein in adults as 0.83-1.04 g/kg/day. In other words, proteins should provide 10-20% of the daily energy intake in an adequate and balanced nutrition plan. However, protein needs of individuals vary according to their age, gender, and physiological status. According to the data in the Türkiye Dietary Guidelines (T.C. Sağlık Bakanlığı, 2022), 21.5% of individuals aged 19 and older in Türkiye consume protein below the estimated average requirement. In addition, the level of vegetable protein intake provided by the mixed diet is 58.2%, and the level of animal protein intake is 41.8%.

The primary source of dietary protein is plant and animal tissues. However, plant and animal proteins differ from each other in terms of their chemical, biological, functional, and nutritional properties. The main animal proteins in foods are milk and its products, meat, seafood, and eggs, while vegetable proteins are cereals, legumes, nuts, oilseeds, and pseudo-grains. Protein ratios in some foods are shown in Table 1 (Day et al., 2022; turkomp.tarimorman.gov.tr).

Table 1

Protein ratios in some foods

Foods	Protein (%)
Milk	3-7
Cheese	25-27
Meat	20-25
Fish	16-21
Eggs	12-17
Grains	7-15
Soy	35-40
Legumes	20-36
Nuts and seeds	9-25
Pseudo cereals	9-24

The quality, as well as the quantity of protein in foods, is an essential criterion for optimal nutrition and health maintenance. Protein quality reflects the extent to which a food protein or a diet meets the metabolic demand for amino acids and nitrogen, which represents the efficient utilization of protein by the body. Two factors are considered for protein quality: Essential amino acid (EAA) pattern and their digestibility. In other words, the usage of dietary protein by the human body depends on the pattern and digestibility of the amino acids that make up the protein in the food (Mansilla et al., 2020).

Essential amino acids cannot be synthesized in the body and must be taken from food. Nine EAA consist of: histidine (His), isoleucine (Ile), leucine (Leu), lysine (Lys), methionine (Met), phenylalanine (Phe), threonine (Thr), tryptophan (Trp) and valine (Val). The body's protein synthesis rate is adjusted according to the slightest intake of essential amino acids. In other words, insufficient information about an EAA in the diet slows down protein synthesis, and this causes various metabolic disruptions. Animal proteins' essential amino acid composition is more balanced than vegetable proteins. Plant proteins are missing one or more of the EAAs. Cereals have low lysine content, and legumes have low methionine and cysteine content. For this reason, it is accepted that the protein quality of plant foods is lower than that of animal foods (Davies & Jakeman, 2020; Köseoğlu, 2019).

The digestibility of a food protein is a measure of the protein's susceptibility to proteolysis. Protein digestibility depends on its structure, the intensity of heat treatment during preparing the meal, and the presence of anti-nutrients. Plant foods contain more carbohydrates, fiber, polyunsaturated fats, and indigestible compounds than animal foods. This results in lower digestibility of plant proteins. The digestibility of animal proteins ranges between 90-95%, while vegetable proteins range between 75-80% (Hertzler et al., 2020). Some food processing changes the digestibility of proteins. Digestibility can be increased via food processing such as soaking, dehulling, heat application, pressure or microwave cooking, germination, fermentation, and refining. However, various reactions, such as non-enzymatic browning reactions, that can occur during food processing can reduce the digestibility of proteins and lead to protein loss (Ohanenye et al., 2022).

Researchers estimate that the world population will exceed nine billion by 2050. This means that while the demand for animal proteins is high, animal protein will not be enough for everyone because they are not sustainable. This is why plant-based proteins are gaining in popularity. Plant foods are more sustainable than animal foods. They are also cholesterol-free, low in saturated fat, and contain fiber. Health authorities recommend increasing plant proteins in the diet due to their potential health effects (Langyan et al., 2022). At this point, improving the protein quality of plant foods comes to the fore. To optimize the amino acid pattern in plant foods, consuming legumes and cereals in a 35:65 ratio is recommended (Atalay & Gökbulut, 2021).

Various methods can calculate protein quality. One of the methods recommended by the World Health Organization, Food and Agriculture Organization of the United Nations, and United Nations University (World Health Organization, 2007) is the PDCAAS method. In this method, the EAA in food is ratioed to the EAA in the reference model, and the food's limiting essential amino acid (LAA) is determined. The LAA is multiplied by the digestibility to obtain the PDCAAS score. A score of one means that the individual can meet all of the EAA needed, while a score of less than one indicates at least one LAA in the diet.

In Turkish cuisine, one of the world's richest cuisines, soups are served with meals due to their satiating and nutritional properties (Batu & Batu, 2018). Soups are consumed in all age groups because they are delicious and contain different ingredients. At the same time, soups are cost-effective and can be prepared quickly, so they are consumed at every meal of the day in Türkiye. Today, it is estimated that more than a thousand soup recipes are created using various cooking techniques in Türkiye. Soups are usually named after the main ingredient they are made from, and a wide variety of ingredients are used in soups to provide a variety of nutrients. Soups cooked in Türkiye can be grouped under five main headings (Güldemir et al., 2018; Özbey & Köşker, 2021).

- Grain and cereal products soups
- Legume soups
- Milk and yogurt soups
- Vegetable soups
- Meat and offal soups (Özbey & Köşker, 2021).

Nutritional studies on various cuisines and dishes are widespread. Existing research often focuses on the overall nutritional composition or protein content of foods (Aykut, 1987; Öney et al., 2023). Comprehensive analysis of amino acid profiles and PDCAAS method for foods seems to be under-explored. The importance of considering both protein quantity and quality in diet planning for a healthy diet is emphasized. This study thought to be a guide in nutritional planning, especially for groups with low protein intake, aimed to calculate the protein quality of some soups consumed in Türkiye with the PDCAAS method.

Methods

Selection of soups

A total of 32 soups, whose ingredients and standard weight list in one portion were specified in the National Menu Planning and Implementation Guide for Mass Nutrition Systems (Places of Mass Consumption) (T.C. Sağlık Bakanlığı, 2020), were included in the study. If the essential amino acid content of the protein food in the soup ingredient was not given in Turkomp, it was excluded from the study because it would cause data loss in the calculation. The study was completed with 25 soups.

Calculation of energy, protein, and essential amino acid content

The ingredients in the soup recipe were entered

into the National Food Composition Database (turkomp.tarimorman.gov.tr). Data on energy, total protein, vegetable and animal protein content, and essential amino acid content were obtained. The total amount was calculated in the Microsoft Excel program.

Calculation of protein quality

PDCAAS method was used to calculate protein quality. PDCAAS is calculated by multiplying the LAA by the digestibility factor.

PDCAAS= (amount of essential amino acids in 1 g protein of food/amount of essential amino acids in 1 g protein for 6 months-3 years)*digestibility factor (World Health Organization, 2007)

Limited Essential Amino Acid Determination: EAAs of 1 g protein in the soup were calculated separately. Each EAA was divided by the value of the same amino acid in the reference protein model. The lowest score gives LAA. WHO (2007) recommends that the reference scoring model determined for children between six months and three years of age be used as the reference value in assessing dietary protein quality for all age groups. Reference values are given in Table 2.

Table 2

Reference values for amino acid requirements for one gram of protein (mg)

References	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
6. month–3 ages	20	32	66	57	27	52	31	8,5	43

AAA: Aromatic amino acids (phenylalanine and Tyrosine); SAA: Sulfur amino acids (methionine and cysteine)

Determination of Digestibility Factor: Data from WHO (2007) guidelines were used. Various sources were taken as a reference for the digestibility factor of foods not published in the guidelines (Table 3).

Table 3

Reference for digestibility factors of the foods included in the soup

Foods	Digestibility Factors (%)	References
Wheat	91	WHO, 2007
Wheat (bread, durum)	86	WHO, 2007
Bulgur	64,5	Ertaş and Türker, 2014
Maize	78	WHO, 2007
Rice	75	WHO, 2007
Eggs	98	WHO, 2007
Milk, cheese, yogurt	95	WHO, 2007
Meat, chicken, fish	94	WHO, 2007
Kidney bean	78	WHO, 2007
White bean	78	WHO, 2007
Lentils (red and green)	79	Stone et al., 2019
Chickpea	75	Stone et al., 2019
Potatoes	84	Hussain et al., 2021
Vegetables	80	Gorissen et al., 2018

The total protein in the soup comes from different foods. The digestibility factor value was taken from the dominant protein source.

Evaluation of data

Microsoft Excel Program was used to calculate the obtained data. If PDCAAS is less than 1, at least one AA is limiting, while PDCAAS ≥1.00 indicates no LAA in food or diet.

Results

Energy, total, animal, and plant protein amounts, essential amino acid amounts, animal/plant protein ratio, protein energy ratio, and PDCAAS values were calculated based on the amounts specified in the soup recipes. A standard portion of soups is 180 grams. The results are given in Table 4.

According to Table 4, the soups with the highest energy content are *Toyga soup* (364.5 kcal), *Yogurt soup* (274.6 kcal), and *Ezogelin soup* (264.8 kcal). The soups with the highest total protein content were *Lebeniye soup* (12.9 g), *Toyga soup* (12.5 g), and *Yogurt soup* (10 g), respectively. While there was no LAA in *Yogurt and Lebeniye soups*, the PDCAAS value was found to be 1.00. All other soups contain at least one LAA. The LAA of *Tomato soup milk*, *Mushroom soup cream*, and *Green lentil soup* are sulfur amino acids. While LAA was histidine in *Köylü soup*, it was found as lysine in other soups.

Discussion

Soups are sometimes the main meal in Turkish cuisine. They are consumed by all segments of society, from infants to the elderly. This study calculated the protein quality of 25 soups consumed in Türkiye. PDCAAS, the method WHO/FAO/UNU recommended, was used in the calculation. In PDCAAS, the soup's 1 g protein EAA pattern is calculated and compared with the reference model to determine the LAA and multiplied by the digestibility factor. It is known that the PDCAAS value of animal protein sources such as meat, chicken, fish, milk, yogurt, cheese, and eggs is higher than that of vegetable protein sources such as cereals, legumes, vegetables, and fruits (Adhikari et al., 2022).

A study conducted in the Netherlands examined two non-consecutive 24-hour dietary recalls of 2150 adult individuals. The protein quality of the food they consumed at meals was calculated using PDCAAS. It has been reported that protein quality is related to the animal-based food groups consumed at that meal. Low PDCAAS at meals has been associated with consuming sweetened beverages, fruits, vegetables, nuts, and legumes. It was emphasized that at higher PDCAAS values, these food groups were partially replaced by milk and meat products (Heerschop et al., 2023).

On the other hand, Tso and Forde (2021) compared a standard omnivorous Western diet with alternative plant-based diets to examine the nutritional impact of switching from animal foods to plant foods. They found that protein quality or quantity is unlikely to cause problems. Many plant proteins and protein mixtures, especially when consuming various plant foods, Daily emphasize that they can meet protein needs. It has been reported that the concern that plant-based foods contain poor protein quantity and quality is unfounded and that most individuals in developed countries tend to exceed their protein requirements.

In this study, the five soups with the highest PDCAAS were *Lebeniye* and *Yogurt soup* (1.00), *Flour soup* (0.90), *Tarhana soup* (0.88), and *Tomato soup milk* (0.87). All of these soups include grains and products. In addition, yogurt, meat, eggs, and legumes are used in *Lebeniye soup*, yogurt and eggs in *Yogurt soup*, meat in *Flour soup*, and milk and dairy products in the recipe for *Tarhana* and *Tomato soup milk* (T.C. Sağlık Bakanlığı, 2020).

Table 4

Energy and protein content, essential amino acid pattern, and PDCAAS of soups

Soup name	Energy (kcal)	Total protein (g)	P/E (%)	Animal protein (g)	Plant protein (g)	ABP/PBP	His (mg)	Ile (mg)	Leu (mg)	Lys (mg)	SAA (mg)	AAA mg)	Thr (mg)	Trp (mg)	Val (mg)	Limiting amino acid	PDCAAS
Yogurt Soup	274.6	10.0	14.6	7.4	2.6	2.85	241.4	589	889.2	635.1	359.5	949.1	399	120.6	666.3	NL	1.00
Lebeniye Soup	249.4	12.9	20.7	9.2	3.7	2.62	352.3	675.5	980.6	848.4	463.8	1029.8	515.0	147.4	694.8	NL	1.00
Flour Soup	175.2	7.9	18.0	5.7	2.2	2.59	230.6	372.1	619.8	531.5	284.6	589.2	319.0	87.2	408.2	Lys	0.90
Tarhana Soup	197.9	6.9	14.0	1.2	5.7	0.0	162.6	367.9	589.9	409.1	232.3	601.8	267.0	89.1	393.2	Lys	0.88
Tomato Soup Milk	202.2	6.9	13.7	4.8	2.1	2.29	151.8	312.8	578.7	437.3	191.5	599.2	262.5	80.6	377.5	SAA	0.87
Spinach Soup	96.9	3.3	13.6	1.4	1.9	0.74	70.1	148.0	276.7	216.3	113.4	270.6	135.2	43.2	180.1	Lys	0.85
Capia Pepper Soup	119.3	2.7	9.1	1.0	1.7	0.59	57.2	116.4	217.4	146.7	96.9	223.3	104.9	31.1	137.6	Lys	0.81
Red Lentil Soup	235.4	12.0	20.4	0.0	12.0	0.0	362.9	572.7	893.0	1524.9	347.1	1092.4	428.6	100.4	597.5	Trp	0.81
Carrot Soup	117.3	2.5	8.5	1.0	1.5	0.67	51.7	110.4	199.9	134.2	85.4	198.8	93.4	27.6	127.6	Lys	0.80
Vegetable Soup Milk (Winter)	189.9	4.9	10.3	1.7	3.2	0.53	99.7	207.1	386.4	287.9	156.0	385	185.3	56.2	273.6	Lys	0.76
Köylü Soup	141.4	4.9	13.9	1.7	3.2	0.53	91.4	184.9	333.1	271.1	131.7	328.2	162.8	47.5	219.7	His	0.75
Broccoli Soup Cream	136.8	4.4	12.9	1.1	3.3	0.33	84.1	170.2	285.7	209.3	140.5	317.6	148.8	47.2	213.1	Lys	0.71
Potato Soup	172.7	3.7	8.6	0.0	3.7	0.0	66.8	160.0	240.9	189.4	109.5	282.6	131.6	50.1	192.7	Lys	0.71
Seasoned Vermicelli Soup	209.8	7.1	13.5	3.5	3.6	0.97	153.0	374.1	511.0	331.7	263.6	594.5	240.2	82.3	375.5	Lys	0.70
Milk Soup	163.6	4.7	11.5	1.7	3.0	0.57	92.5	189.3	376.2	200.1	169.1	378	154.1	48.5	224.3	Lys	0.70
Corn Soup Cream	139.4	3.3	9.5	1.1	2.2	0.5	72.3	134	291.5	160.6	103.1	285.6	118.9	30.1	180.3	Lys	0.68
Ezogelin Soup	264.8	10.9	16.5	0.0	10.9	0.0	313.1	511.4	817	1207.3	328.9	970.5	385	95.8	552.8	Trp	0.67
Toyga Soup	364.5	12.5	13.7	3.5	9.0	0.39	276.1	625.1	914.7	530.0	442.8	1029.6	422.4	141.0	624.4	Lys	0.67
Mushroom Soup Cream	137.0	5.4	15.8	1.1	4.3	0.26	92.5	182.2	289.7	253.3	114.9	300.6	149.7	45.5	191.1	SAA	0.67
Green Lentil Soup	200.5	9.4	18.8	0.0	0.0	0.0	221	421.5	689.7	581.6	201.8	771.7	364.0	90.7	498.5	SAA	0.66
Vegetable Soup (Winter)	175.7	3.6	8.2	0.0	3.6	0.0	69.5	144.7	237.3	174.0	109	252.8	121	41.0	193.0	Lys	0.64
Vegetable Soup (Summer)	174.9	3.8	8.7	0.0	3.8	0.0	74.2	159.2	251.2	178.1	106.7	282.6	127.5	45.1	202.8	Lys	0.62
Yüzük Soup	115.7	2.9	10.0	0.0	2.9	0.0	67.8	133.1	207.0	143.8	89.6	215.9	102.1	29.7	133.4	Lys	0.61
Rice Soup	192.9	3.7	7.8	0.0	3.7	0.0	78.9	157.9	291.5	129.2	127.1	295.6	128.4	42.1	205.6	Lys	0.46
Tutmaç Soup	153.8	3.6	9.4	0.0	3.6	0.0	66.1	136.8	240.8	89.8	127.9	265.9	98.1	36.1	153.6	Lys	0.38

A standard portion of soups is 180 grams; P/E (%): The ratio of energy supplied from protein; ABP/PBP: Animal-based protein/plant-based protein; AAA: Aromatic amino acids (phenylalanine and tyrosine; SAA: Sulfur amino acids (methionine and cysteine); NL: No limiting amino acid

Animal proteins have a balanced essential amino acid pattern and higher digestibility than vegetable proteins (Day et al., 2022; Ewy et al., 2022). Therefore, it is unsurprising that the protein quality of these soups containing animal-derived foods is high. The ABP/PBP at these soups was higher than 2.00. (Table 4). This study found LAA for *Tarhana* and *Yogurt soups* to be lysine. However, Kanbir (2021), found the PDCAAS of *Tarhana soup* to be 0.64 and that of *Yogurt soup* to be 0.9 and reported that the LAA was valine. The results of Kanbir's study differ from the results of this study. This difference may be due to the list of ingredients in the recipes.

The five soups with the lowest protein quality were *Tutmaç soup* (0.38), *Rice soup* (0.46), *Yüzük soup* (0.61), *Vegetable soup (summer)* (0.62), and *Vegetable soup (winter)* (0.64) (Table 4). *Tutmaç, Rice, and Vegetable soups* are prepared with grains and vegetables. The protein in these soups is provided from only plants food (T.C. Sağlık Bakanlığı, 2020). Animal proteins provide a more balanced amino acid pattern and improve protein quality. When the protein quality of cereals and vegetables is analyzed, one or more EAAs are missing (Ewy et al., 2022). Grains are usually deficient in lysine; in these soups, lysine appears to be the LAA. This explains the lower protein quality compared to soups containing animal protein.

The protein content of the *Yüzük soup* is also provided by cereal and legume proteins. Grains are deficient in lysine, while legumes are generally deficient in sülfür amino acids. Combining grain and legume proteins can provide a balanced amino acid pattern. Current global consumption patterns suggest that 6 g of cereal protein is consumed per 1 g of legume protein. To optimize protein quality scores, a ratio of 2 g of cereal protein per 1 g of legume protein is required (Davies & Jakeman, 2020; FAO, 2013). Preparing recipes with this ratio in mind can improve protein quality.

Soups containing milk, grains, and vegetables in the recipe were *Spinach soup* (0.85), *Capia pepper soup* (0.81), *Carrot soup* (0.80), *Vegetable soup milk (winter)* (0.76), and *Corn soup cream* (0.68). In all of these soups, the LAA is lysine. Approximately 40% of vegetable protein consumption in Türkiye consists of lysine-poor cereals. Enriching cereal products with foods containing lysine amino acids can significantly improve protein quality (T.C. Sağlık Bakanlığı, 2022). Schaafsma (2012) reported that 1.28 g milk protein or 8.5 g chickpea protein is required to compensate for a deficiency of 1 g lysine. By increasing the amount of milk in these recipes, the amino acid pattern can be balanced, and the protein quality of the soup can be improved. The PDCAAS values of *Vegetable soup milk (winter)* and *Vegetable soup (winter)* can be given as an example. It is seen that the PDCAAS of vegetable soup increased from 0.64 to 0.76 with the addition of milk, i.e., the protein quality increased. Similarly, balance can be achieved by adding legumes. Still, the organoleptic properties of the recipe may change due to the need to add a large amount of legume protein, so the ingredients in the recipe may need to be revised.

Energy intake is as influential as the amount of protein to ensure adequate and balanced dietary information. This is because the adequacy of dietary protein is affected by energy intake. Inadequate energy intake may lead to a negative nitrogen balance, which may reduce the adequacy of protein intake. Therefore, protein and energy intake should be considered together (Mariotti & Gardner, 2019). Proteins should provide 10-20% of dietary energy. In this context, it is seen that the energy provided from protein in *Rice, Tutmaç, Corn, Carrot, Capia pepper, Potato, Vegetable (winter),* and *Vegetable (summer) soups* is below 10%. Adding high-protein foods to a menu that includes soup can increase the energy provided by protein by more than 10%. Another option is

adding foods with high protein content, such as eggs, milk, yogurt, minced meat, and chicken, to the soup (T.C. Sağlık Bakanlığı, 2022).

Infants, children, and geriatric are in the at-risk group for adequate protein intake. Individuals in this group tend to prefer soft and easily consumable foods such as soups. In addition, in the nutritional treatment of obese individuals, foods with low energy density along with quality protein sources are preferred (T.C. Sağlık Bakanlığı, 2022). Since soup provides a feeling of fullness quickly, it makes it easier to control energy intake in obese individuals. It is recommended that soups with high protein quality be added to the diet. Considering that soups are frequently preferred foods in Türkiye, these results will guide dietitians to increase the amount and quality of dietary protein when planning diets for their clients. Therefore, whether the results are accurate in digestibility is not being determined. In addition, protein quality changes that occur during food processing were ignored in this study.

Conclusion

Proteins are macronutrients that have many functions in the body. Proteins should provide 10-20% of dietary energy. Insufficient protein intake causes loss of muscle mass and strength and various diseases. This study calculated the protein quality of some soups consumed in Turkey using PDCAAS. It has been observed that the protein quality of soups containing animal protein in the recipe increases. The lowest protein quality was observed in recipes containing only grain and vegetable protein. Protein quality has increased with recipes containing more than one vegetable protein or blended with animal-derived proteins instead of recipes containing a single vegetable protein source. To protect public health and create sustainable nutrition models, the amount of protein and the quality of the protein should be considered. Soups with high protein quality, such as *Lebeniye* and *Yoghurt soup*, should be preferred especially in groups with special needs such as children and the elderly. In addition, adding high-protein soups to the diet of individuals who receive low-energy nutrition therapy or have limited physical activity helps maintain energy control by providing a feeling of fullness and contributes to adequate protein intake.

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