

Assessment of vitamin compositions and cholesterol levels of carp (*Cyprinus carpio carpio*) and rainbow trout (*Oncorhynchus mykiss*) caviars

Sazan (*Cyprinus carpio carpio*) ve gökkuşağı alabalığı (*Oncorhynchus mykiss*) havyarlarının vitamin kompozisyonu ile kolesterol düzeylerinin belirlenmesi

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Received date: 01.11.2018

Accepted date: 26.06.2019

How to cite this paper:

İnanlı, A.G., Çoban, Ö.E., Yılmaz, Ö., Özpolat, E. & Kuzgun, N.K. (2019). Assessment of vitamin compositions and cholesterol levels of carp (*Cyprinus carpio carpio*) and rainbow trout (*Oncorhynchus mykiss*) caviars. *Ege Journal of Fisheries and Aquatic Sciences*, 36(3), 293-299. DOI: [10.12714/egejfas.2019.36.3.10](https://doi.org/10.12714/egejfas.2019.36.3.10)

Abstract: In this study, roes obtained from carp (*Cyprinus carpio carpio*) that were caught from Keban Dam Lake (Elazığ) and the cultured rainbow trout (*Oncorhynchus mykiss*) were processed as caviar and compositions of proximate and vitamins, cholesterol levels were determined in the products. In the research, roes obtained from mature fish were processed under aseptic conditions by suitable procedures for different fish species. The obtained caviars were weighed as 75 grams and filled in 200 ml capped glass jar and stored in +4 °C for 28 days. As a result of the analysis in the study, the amount of dry matter was determined to be 35.94% in roes obtained from rainbow trout and 31.28% in roes obtained from carp. The average protein content in raw roe obtained from rainbow trout was determined to be 24.32%, it was determined to be 18.25 % in carp. In this study, the fat content in roes obtained from rainbow trout was determined to be 9.14%, but it did not show much change during processing and it was determined to be 8.84% in the end product. During the production and storage of the caviar produced from rainbow trout and carp, the fat-soluble vitamin composition and cholesterol levels were determined. During the study, it was found that the amounts of vitamin A between rainbow trout and carp caviars were significantly different ($p < 0.001$). Vitamins D and K were not detected in the caviar samples. As a result of analyzes, cholesterol levels were determined 73.76 mg/100 g in rainbow trout roe and 10.82 mg/100 g in carp roe and it was observed that these values were not changed significantly during the processing and storage periods (on 0th, 7th, 14th, 21st and 28th days).

Keywords: Caviar, proximate composition, cholesterol, vitamin

Öz: Bu çalışmada, Elazığ ili Keban Baraj Gölü'nden avlanan sazan balıkları (*Cyprinus carpio carpio*) ve kültür gökkuşağı alabalıklarından (*Oncorhynchus mykiss*) elde edilen yumurtalar havyar olarak işlenerek ürünün besin ve vitamin kompozisyonu ile kolesterol düzeyleri saptanmıştır. Araştırmada tam olgunlaşmış ve sağlam aşamasına gelmiş anaç balıklardan sağlanarak alınan yumurtalar elde edilen balık türüne uygun farklı şekillerde aseptik koşullar altında işlendi. Elde edilen havyarlar 75'er gram tartılarak kapaklı cam 200 ml'lik kavanozlara yerleştirildikten sonra 28 gün süreyle +4 °C'de muhafazaya alındı. Çalışmada yapılan analizler sonucunda, kuru madde miktarının gökkuşağı alabalıklarından elde edilen yumurtsalarda % 35.94, sazandan elde edilen yumurtalarda % 31.28 olarak belirlenmiştir. Gökkuşağı alabalığından elde edilen ham yumurtada ortalama protein içeriği % 24.32, sazanlarda % 18.25 olarak belirlenmiştir. Bu çalışmada, gökkuşağı alabalığından elde edilen balık yumurtasındaki yağ içeriği % 9,14 olarak tespit edilirken işleme sonucunda bu değerin fazla bir değişiklik göstermediği ve sonunda % 8,84 olarak tespit edilmiştir. Gökkuşağı alabalığı ve sazadan üretilecek havyarın üretimi ve depolanması sırasında yağda çözünen vitamin kompozisyonu ve kolesterol düzeyleri belirlenmiştir. Çalışma sırasında gökkuşağı alabalığı ve sazan havyarlarında belirlenen A vitamin miktarları arasındaki farkın istatistikî olarak önemli olduğu ($p < 0,001$) tespit edilirken, havyar örneklerinde D ve K vitaminleri tespit edilmemiştir. Yapılan analizler neticesinde kolesterol düzeyleri gökkuşağı alabalığından sağlanan yumurtalarda 73,76 mg/100 g sazanlarda alınan yumurtalarda ise 10,82 mg/100 g belirlenirken üretim ve muhafaza aşamalarında (0, 7, 14, 21 ve 28. günlerde) bu değerlerde önemli bir değişim görülmemiştir.

Anahtar Kelimeler: Havyar, besin kompozisyonu, kolesterol, vitamin

INTRODUCTION

As a result of scientific studies, which have been conducted in various areas, positive effects of fish in diet on human health has become well-known. Increasing fish consumption in diet is very important in terms of economy and health. Nations, which are aware of the importance of a balanced diet is important, have been seeking new products, which can satisfy consumers sensationaly and may be prepared easily, to enrich their protein resources in food industry. These nations have been making investments for this purpose (McCune 1988; Göğüş and Kolsarıcı, 1992; Varlık et al., 2004). The seafood, particularly roes (caviar), which has high nutritional value, are in a position to meet these needs of the people. However, it is among the most expensive food due to limited production opportunities as it is hard to obtain (McCune, 1988).

It is known that the caviar has been produced since 13th century and it was recorded that Russia has been producing caviar since 16th century. Towards the end of the 19th century, the caviar processing techniques developed in parallel to the development of fishing industry (Altuğ and Bayrak 2003; Varlık et al., 2004).

The protein content of caviars changes between 23% and 35% (İnal, 1992). It was recorded that red caviar obtained from salmonids had 49% water, 32% protein, 11% fat, 7% inorganic matters and 3% salt. It was also determined that black caviar of high quality consisted of 48% organic matters, 40% water and 12% fat in black caviar of high quality (Altuğ and Bayrak, 2003). In fried cod caviar, 21% protein, 12% fat, 3% carbohydrate and 207 calories/100 grams were determined (Göğüş and Kolsarıcı, 1982). Fresh unprocessed mullet caviar has 61.77% moisture, 23.9% protein, 9.9% fat, 5.1% ash and 3% salt, it was determined dry salted caviar of 3.92% moisture, 24.5% protein, 11.5% fat, 9.5% ash and 8.7% salt content (KarakAŞ, 2008). 49,2% water, 25,4% protein and 11,8% fat was assesed in the caviar of rainbow trout (Ozpolat and Patir, 2010).

During preparation stage of caviar, even small mistakes affect the quality on a great scale. In order to obtain good quality caviar, attention and care are required in every stage of processes such as extracting and washing roes (McCune, 1988).

In the study, it was aimed to assess nutrient and vitamin composition, cholesterol levels of caviar samples before processing stage, during processing and storage days (on 0th, 7th, 14th, 21st and 28th days).

MATERIAL AND METHOD

In this study, carp (*Cyprinus carpio carpio*) which was caught in Keban Dam Lake (Turkey) and rainbow trout (*Oncorhynchus mykiss*) which is a product of

hatchery were used.

Roes of rainbow trout between ages of 4-5 were obtained in January in order to be used in caviar production in the study. Roes of carps between ages of 3-4 caught in Keban Dam Lake (Turkey) were obtained in June. 12 each carp (1,500-2,000 kg) and rainbow trout (2,000-2,500 kg) were used in order to obtain roughly 4 kg caviar from each fish by considering the analysis, repeats and wastage. Study had 2 replicates and analyses had 3 parallels.

Preparation of caviar samples and storage

In the study roes of broodstock of such species of fish were processed as caviar in Faculty of Fisheries of Fırat University. Roes obtained from mature fish were processed under suitable conditions by treatments for different fish species. The processed caviars were weighed as 75 grams and filled in 200 ml capped glass jar and stored in +4 °C for 28 days.

In this study, flow diagram of the production of obtained caviar samples is shown in Figure 1.

Chemical analysis

In this study was determined proximate and vitamin compositions, cholesterol levels of caviar samples before processing stage, during processing and cold storage days (on 0th, 7th, 14th, 21st and 28th days) at +4 °C . Whereas the study was conducted as three parallel analyses, the experiment repeated two times.

Proximate composition: The dry matter content, crude protein, crude oil and crude ash of caviar samples were measured according to standard methods (AOAC, 2002). The pH values of caviars were determined with a pH meter (Thermo Scientific Orion 3-Star). The sample was homogenized in distilled water in the ratio 1:10 (wt/vol), and the measurement was done by a pH meter (AOAC, 2002).

Cholesterol and vitamin analyses: Total lipids were extracted with hexane-isopropanol (3:2 v/v) as described by Hara and Radin (1983). About 1g of the samples were taken and homogenized.

The 5 ml supernatant was taken to tubes and 5 ml KOH was added to it. The mixture was incubated for 15 min at 85 °C. It was then cooled under room condition and 5 ml of distilled water was added. Hexane-isopropanol extracts were combined and evaporated. The residue was dissolved in 1 ml of acetonitrile: methanol centrifuged and the supernatant was used for cholesterol content determination.

During the analysis cholesterol content were used the fully automatic HPLC was used for cholesterol content. The equipment for HPLC consisted of a pump (LC-10ADVP), a UV-vis detector (SPD-10AVP) a column oven (CTO-10ASVP), an auto sampler (SIL-10ADVP) a

degasser unit (DGU-14A) and a computer system with Class VP software (Shimadzu, Kyoto, Japan). Discovery RP-Amide C16 column (150 mm×4.6 mm, 5 μ m; Sigma, USA) was used as the HPLC column and mixture of acetonitrile/methanol (%60+%40, v/v) was used as the mobile phase and flowrate 1 ml/min. Detection was performed at 215 nm by UV-vis detector and 40 °C column oven. Detection was performed at 326 nm for retinol and retinol acetate, 202 nm for α -tocopherol and phytostreoller, 265 nm for vitamins D and K (Katsanidis and Addis 1999; L'opez-Cervantes et al. 2006).

Data analysis: The data collected during production and storage of caviars of rainbow trout and carp prepared for experiment in the study were subjected to statistical analysis. In two recurrence studies, mean values and standard deviations of the results obtained as a result of analysis were determined. SPSS® 22.0 computer package statistics program was used for statistical analysis. Mann-Whitney U test was employed for comparing dual groups and Kruskal-Wallis test was used so as to determine whether there was more than two significant differences between the groups (SPSS Inc. Chicago II.)

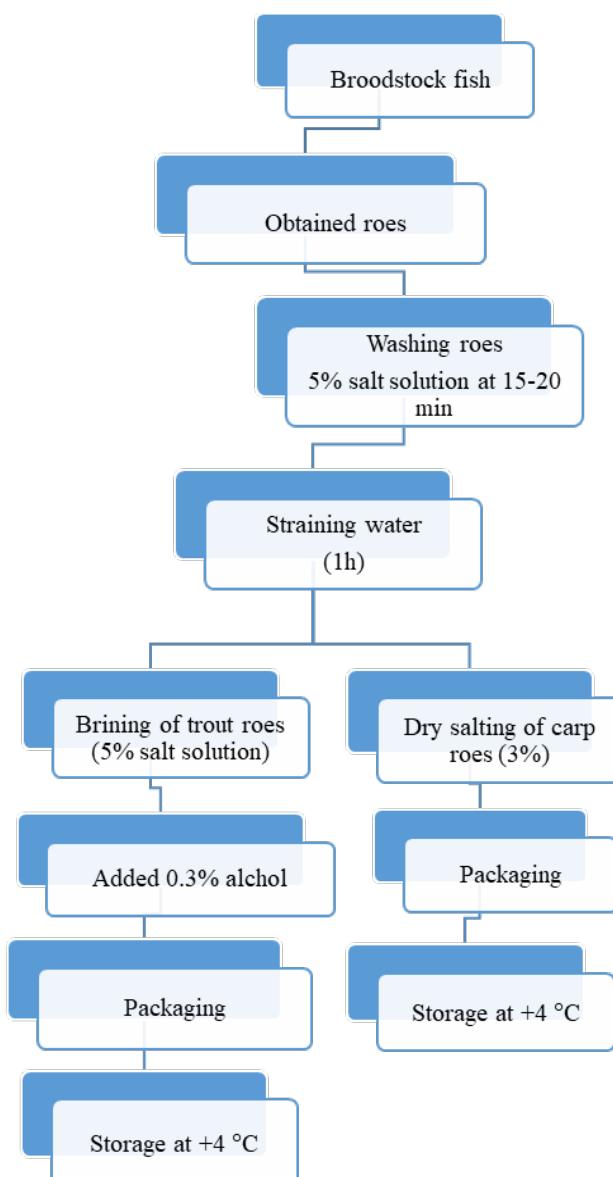


Figure 1. Flow diagram of caviars production

RESULTS AND DISCUSSION

Nutrient composition and salt content of the roes and the product during caviar production stages

The chemical composition of caviar which is a high nutritional value food varies according to fish species and processing techniques. The trout and carp roes used in the production of the caviar samples prepared in the study and the nutrient composition (dry matter, ash, fat and protein) and salt contents of the samples during caviar production stages are presented in Table 1.

As a result of the analysis in the study, the amount of dry matter was determined to be 35.94% in roes obtained from rainbow trout and 31.28% in roes obtained from carp. The amount of dry matter contained in caviar varies according to the fish species from which it is obtained and according to the processing technique. As the caviar is obtained, the amount of dry matter increases since the water is expelled when the salt enters the roes at the end of the applied salting process. [Sengör et al. \(2000\)](#) determined the amount of dry matter in raw roes obtained from flathead mullet to be 45.57%. [Bledsoe et al. \(2003\)](#) found the rate of dry matter in caviar obtained from salmon to be 50% and reported that the rate of dry matter in caviar changed

according to the type of salmon from which caviar was obtained. Namely, the dry matter amounts of the caviar according to the species it was obtained from were reported to be 40-50% in *Oncorhynchus gorbuscha*, 44-45% in *Oncorhynchus keta*, 42-44% in *Oncorhynchus nerka* and 30-49% in *Oncorhynchus ishawischa*. [Inal \(1992\)](#) stated the moisture in good-quality caviar to be 45%. In a study [Özpolat \(2006\)](#) conducted on the production of rainbow trout caviar, he determined the amount of dry matter in raw roe to be 36.10%. [Gürel İnanlı et al. \(2010\)](#) determined the amount of dry matter in raw roe obtained from rainbow trout to be 38.84%. The incompatibility in the findings can be attributed to the diversity of the fish species from which caviar is obtained and to the different salt rates and processing techniques applied.

The mineral content of caviar increases compared to raw roe after salting. The average amount of ash in raw roes of rainbow trout (2.01%) determined in Özpolat's research ([2006](#)) was close to our finding. In the same study, due to different salinity ratios, the salinity value determined in salted caviar (12.44%) was higher than our findings. In another study, the average amount of ash in raw roe obtained from rainbow trout was determined to be $2.21 \pm 0.02\%$ ([Gürel İnanlı et al., 2010](#)). In a study conducted on the roes of flathead mullet, the ash rate was determined to be 5.08% in raw roes, 7.17%

Table 1. The values of salt and proximate composition of roes and caviars during production stages.

<i>Chemical Parameters</i>	<i>Caviar type</i>	<i>Roe</i>	<i>End washing</i>	<i>End salting¹</i>	<i>End alcho²</i>
<i>Dry matter</i>	Trout	35.94±0.32	37.81±1.07	38.29±0.23	37.49±0.19
	Carp mirror	32.28±0.24	33.08±0.19	35.48±0.76	—
<i>Ash</i>	Trout	1.41±0.38	2.13±0.82	2.59±0.36	2.04±0.21
	Carp mirror	1.12±0.22	1.97±0.37	3.48±1.59	—
<i>Lipid</i>	Trout	9.14±0.06	8.83±0.52	9.44±0.43	8.84±0.23
	Carp mirror	10.75±0.49	9.44±0.11	11.34±0.46	—
<i>Protein</i>	Trout	24.32±0.06	23.56±0.36	23.24±0.31	22.21±0.43
	Carp mirror	18.25±0.41	17.84±0.21	19.07±0.92	±
<i>Salt</i>	Trout	—	1.89±0.21	2.09±0.08	2.51±0.23
	Carp mirror	—	1.15±0.16	2.42±0.15	—

¹ Final product of roes obtained from carp mirror

² Final product of roes obtained from trout

in processed roes and 10.14% in waxed roes (Şengör et al., 2002). Altuğ and Bayrak (2003) detected 7% ash content in red caviar. It can be said that the diversity of these findings is derived from the different fish species and processing techniques.

In this study, the fat content in roes obtained from rainbow trout was determined to be 9.14%, but it did not show much change during processing and it was determined to be 8.84% in the end product. In roes obtained from carp, 11.34% fat was determined in 10.75% prepared caviar. In another study, the average fat content in caviar obtained from salmon was determined to be 10.9-19.4% (Wirth et al., 2000). Himelbloom et al. (1998) detected 11.00% fat in caviar processed with salmons (Ikura), and Şengör et al. (2002) determined 6.89% fat content in raw caviar, 11.58% in processed caviar and 21.27% in waxed caviar in a study related to the caviar obtained from flathead mullet. In another study related to the caviar obtained from salmon, it was reported that the fat content varied between 8% and 25% according to fish species (Bledsoe et al., 2003). In a study related to the caviar obtained from rainbow trout and its storage, the fat content was determined to be 11.07% in raw roe and 11.81-11.85% in processed roe preserved for 84 days (Özpolat, 2006). In another study on the caviar obtained from rainbow trout, the fat content in raw roe was determined to be 11.70% (Gürel İnanlı et al., 2010). The fat amounts found in the study are relatively similar to those in the literature, and it can be stated that the differences result from the differences in fish species and the applied processing techniques.

In this research, the average protein content in raw roe obtained from rainbow trout was determined to be 24.32%, but it was determined to be 22.21% in caviar. In a study on flathead mullet (*Mugil cephalus*), the protein amounts were determined to be 25.52% in roes, 35.38% in salted caviar and 40.83% in waxed caviar (Şengör et al., 2002). Wirth et al. (2000) reported that caviar obtained from sturgeons had protein content between 26.2% and 31.1%. Bledsoe et al. (2003) noted that the protein amounts in the caviar obtained from different trout species and prepared by different techniques were as follows; 23% in *Oncorhynchus gorbuscha*, 27% in *Oncorhynchus keta*, 20% in *Oncorhynchus nerka* and 21% in *Oncorhynchus ishawyischa*. Gürel İnanlı et al. (2010) determined the protein content in raw roe obtained from rainbow trout to be 24.87%. The protein content we founded in this study was often consistent with the findings in the literature, but differences can be attributed to the differences in species and processing techniques.

The salt used in preparing caviar is a factor that affects both the storage period and the flavour of the product. In our study, the salinity rate of the caviar we

obtained from rainbow trout was determined to be between 1.89-2.51% on average during the process while the amount of salt in the caviar we processed with roes obtained from carp was determined to be between 1.15-2.42%.

Vitamins and cholesterol levels during production and storage of rainbow trout and carp caviar

During the production and storage of the caviar produced from rainbow trout and carp, the fat-soluble vitamin composition and cholesterol levels were determined. These data are presented on Table 2.

At least 13 vitamins are defined as required for humans, all of which are found in fish, with irregular distribution in tissues. The amount of vitamin varies according to fish species. The amounts of water-soluble vitamins B and C found in water products are almost the same as those found in terrestrial animals whereas fat-soluble vitamins D, E and K are generally more (Pigott and Tucker, 1990). In our study, the fat-soluble vitamin levels of the samples examined were determined. In our samples, vitamins D and K were not found while vitamins A and E levels were determined.

Vitamins that are very important and necessary for human nutrition should be taken daily with foods. Daily intake values were maximum 0.6 mg/day in males and 0.5 mg/day in females for vitamin A and 15 mg/day for vitamin E. Taking these values into consideration, trout caviar or carp caviar is important for vitamin A in terms of human nutrition. In respect to vitamin E, carp caviar is on the foreground.

In our study, 0.70µg/g vitamin A was detected in roes obtained from rainbow trout, but no significant change was observed in this value during the production and storage. In raw roes obtained from carp, vitamin A was determined to be 0.30µg/g. There is no significant change in the amount of vitamin A detected in carp roes during the production and storage of the caviar. In the research, it was determined that the difference between vitamin A amounts detected in rainbow trout and carp caviar was statistically significant ($p < 0.001$). In the research, average amount of vitamin E was determined to be 0.70µg / g in roes obtained from carp, but no significant change was observed in this value during the production and storage. There was no significant change in the amount of vitamin E detected in carp roes during caviar production and storage. In the study Olgunoglu and Olgunoglu (2011) conducted, they found out that vitamin A value in *Mugil cephalus* caviar increased to 2.95 after being processed while it was determined to be 1.54 in raw roe; similarly they determined that vitamin E increased from 4.56 to 9.07 and vitamin D from 3.2, to 13.05. This result differs

from the data obtained in the study. This difference is thought to be due to the difference in fish species that were used and the different processing conditions.

Cholesterol is found in all animal fats, blood and gall. The average amount of cholesterol in humans varies between 150-200g though. The presence of high amount of cholesterol in the blood causes accumulation and hardening in veins. The American National Cholesterol Training Program reported that cholesterol taken with daily food should not be more than 300mg in people with high cholesterol levels. The level of cholesterol in fisheries depends on fish species and seasonal and regional factors. The level of cholesterol was determined to be 43mg/100g in cod fish, but it was determined to be 59mg/100g in salmon

and 152mg / 100g in shrimp ([Çaklı, 2007](#)).

As a result of the analysis conducted in our study, cholesterol levels were determined to be 73.76mg/100g in roes obtained from rainbow trout, and 10.82 mg/100g in roes obtained from carp, but no significant change was observed in these values during production and storage. The cholesterol levels determined during production and storage were higher in the samples prepared from rainbow trout than those prepared from carp. Furthermore, it was also found out ($p < 0.001$) that this difference was statistically significant between the amounts of cholesterol determined in rainbow trout and carp caviar. No literature data regarding the cholesterol levels in the caviar have been found.

Table 2. Compositions of vitamin and cholesterol levels of roes and caviar samples during processing and storage days

Biochemical Parameters	Caviar type	Production stages				Storage periods (Days)				
		Roe	End washing	End salting ¹	End alcohol ²	7 th	14 th	21 th	28 th	a ²
Retinol (µg/g)	Trout	0.70±0.07	0.47±0.10	1.63±0.24	0.72±0.03	0.21±0.03	0.83±0.31	0.78±0.31	0.45±0.07	***
	Carp mirror	0.30±0.07	0.28±0.10	0.28±0.03	-	0.33±0.03	0.20±0.07	0.20±0.07	0.30±0.00	
α tocopherole (µg/g)	Trout	-	-	-	-	-	-	-	-	-
	Carp mirror	42.87±0.74	52.75±1.97	54.10±0.49	-	55.65±0.28	60.95±5.30	61.15±4.94	54.33±6.89	
Cholesterol (mg/100g)	Trout	73.76±3.42	65.03±2.35	74.01±4.15	71.01±3.28	72.81±5.18	65.89±2.19	88.77±4.13	81.23±3.20	***
	Carp mirror	10.82±5.60	11.25±2.13	12.73±2.47	-	13.52±3.78	12.30±12.86	10.65±1.286	16.11±2.33	

¹: D and K vitamins were not determined in the samples

²: Statistical significance ***: $p < 0.01$

CONCLUSIONS

As a result; the caviars obtained from carp and rainbow trout and nutrient quality (moisture, protein, fat, ash, salt, pH) and vitamin composition and cholesterol levels of the product were determined in this study. It is not much available in the literature that the production of a new product by evaluating rainbow trout and carp roes.

It was found that the amounts of the vitamin A between rainbow trout and carp caviars were significantly different ($p < 0.001$). Vitamins D and K were not detected in the caviar samples. As a result of analyzes, cholesterol levels were determined 73.76

mg/100 g in rainbow trout roe and 10.82 mg/100 g in carp roe and it was observed that these values were not changed significantly during the processing and storage periods.

Determination of food value with vitamin composition and cholesterol levels of these products were evaluated both in terms of producers and consumers, also these data will contribute in fisheries technology and scientific literature.

ACKNOWLEDGMENTS

The authors wish to thank the Scientific and Technological Research Council of Turkey (TÜBİTAK) for the financial support (111O055).

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DOI: [10.1002/1521-3803\(20000701\)44:4<233::AID-FOOD233>3.0.CO;2-1](https://doi.org/10.1002/1521-3803(20000701)44:4<233::AID-FOOD233>3.0.CO;2-1)