



Monitoring of the Source of Gelatin in Dietary Supplement Capsules Sold on the Internet

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ABSTRACT - Determining the origin of the components in commercially available gelatin, a purified protein derived mostly from pig skin and bovine tissue, is a challenge, leading to concerns on the grounds of religious beliefs and health. Therefore, regular monitoring of labeling compliance by food control authorities is also necessary. In this study, we monitored the origin of gelatin capsules from 181 commercial dietary supplements that were available for purchase on the internet, using species-specific PCR assays. Fifty five products were labeled correctly, declaring that they used bovine-, fish- and plant-derived gelatin, whereas the other 126 capsules were labeled “gelatin” without specifying the origin. Gelatin in these capsules was obtained from cattle (n = 51), pigs (n = 31), or both (n = 44). Therefore, it is important to declare all of the raw materials used to produce gelatin capsules on the labels to best protect consumers’ rights, religious beliefs, and health.

Key words : Species-specific Polymerase Chain Reaction, Gelatin Capsules, Labeling Compliance

Abbreviations : HPMC, hydroxypropyl methylcellulose; PCR, polymerase chain reaction

In South Korea, capsules are defined by the Korean Food Code¹⁾ as a type of food formulation containing gelatin, glycerin, and other additives. Gelatin is one of the major constituents in a wide range of food products, pharmaceutical medicine capsules, and cosmetics. The majority of edible gelatin is obtained by the hydrolysis of collagen extracted from bovine and porcine hide and splits. The production of gelatin involves several processing steps, including the acidic or basic hydrolysis of raw materials, high-temperature and high-pressure extraction with water, sterilization, and drying. Hence, determining the origin of commercially available gelatin is a challenge. Moreover, only a few studies have focused on the identification of the origin of gelatin, gelatin-containing foods, and capsule shells²⁻⁴⁾. Therefore, the variation and accuracy of the components of gelatin products and the labels remains unknown, posing a threat to consumer rights and manufacturer transparency.

Various dietary supplements (vitamins, minerals, and herbal products) manufactured by either Korean or foreign companies can be easily purchased over the internet; thus, their popularity has increased for the improvement of general immunity and self-treatment of diseases. This rise in the consumption of gelatin capsules has raised concerns from the point of view of health and religious beliefs^{2,3,5,6)}. Dietary supplement capsules are most commonly composed of gelatin obtained from cattle, pigs, fish, or plants. Therefore, the information about the source of gelatin provided in the label can be classified into three groups: (i) mammalian origin, labeled “gelatin”, without specifying the source species; (ii) fish origin, declared as marine or fish gelatin; and (iii) plant origin, labeled hydroxypropyl methylcellulose (HPMC) or vegetarian gelatin. Consumers must rely on accurate labeling information provided by the manufacturers to identify the raw materials used in the production of the gelatin capsules, which is particularly critical for certain consumers such as vegetarians, Muslims, and Hindus, because the consumption of certain food items is prohibited by their religion^{2,3,5,7)}. However, some dietary supplements are simply labeled “gelatin”, without identifying the source, which deprives consumers from the sufficient information needed to protect their religious beliefs or their rights to know and choose what they want to eat. Therefore, verifi-

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cation of labeling compliance can help to protect consumer rights and beliefs, and enhance their confidence in gelatin-based products.

We previously developed specific polymerase chain reaction (PCR) assays to determine the origin of gelatin in capsules, and reported the successful verification of the labeling compliance of gelatin capsules sold as dietary supplements⁸⁾. These assays can be used to accurately identify whether the source of gelatin is cattle, pigs, fish, or plants. In the present study, we used these assays to monitor the origin of 181 commercially available gelatin capsules sold via the internet as health supplements and verified their labeling.

Material and Methods

Samples

A total of 181 different commercially available gelatin capsules, marketed as health supplements, manufactured by American (n = 166), Canadian (n = 11), Norwegian (n = 3), and Korean (n = 1) companies, were purchased via the internet. The gelatin capsules were categorized into five groups according to their labeling information: gelatin (n = 126), plant gelatin (n = 37), bovine gelatin (n = 12), halal and/or kosher gelatin (n = 4) and fish gelatin (n = 2).

DNA extraction and whole-genome amplification

DNA from these capsules was extracted as described previously by Lee et al.⁸⁾. To obtain a larger quantity of DNA from the gelatin capsules, DNA extracts were amplified using the GenomePlex[®] Whole Genome Amplification (WGA) kit (Sigma-Aldrich, St. Louis, MO, USA) according to Lee et al.⁸⁾.

PCR amplification and detection

The information about the primer sets for bovine, porcine, fish, and plant gelatin is provided in Table 1. PCR amplification was conducted as previously described by Lee et

al.⁸⁾, and the amplified fragments were analyzed by 2.0% agarose gel electrophoresis.

Results and Discussion

Of the 181 gelatin capsules investigated in this study, the labels of 126 products contained the word “gelatin” but did not specify its source. The labels of the remaining 55 dietary supplements provided detailed information about the source of gelatin, specifying fish (n = 2, fish or marine gelatin), plant (n = 37, HPMC, modified food starch, cellulose, or vegetarian gelatin), bovine (n = 12, bovine) or halal and/or kosher (n = 4) as the source. The identification of different materials in the capsules as detected using the species-specific PCR assays is listed in Table 2. Positive results were detected with the plant universal PCR assay for all the 37 samples that declared plant sources as the raw material for gelatin on their labels. Fish DNA was detected with the fish universal PCR assay in the two capsules whose labels mentioned marine and fish gelatin. In 12 samples declared using 100% bovine material, pig and fish DNA was not detected. In addition, our PCR assay demonstrated that two capsules labeled as halal and kosher were plant gelatin, and two kosher capsules were either bovine or plant gelatin. Thus, our results suggest that there is generally good consistency between the labeling information provided by manufacturers and the actual ingredients used to make the capsule. However, we could not confirm the labeling compliance for the remaining 126 capsules because of the limited information provided about the raw materials. As shown in Table 2, these 126 gelatin capsules of unknown source were positive in the bovine-specific and/or porcine-specific PCR assays, suggesting that the gelatin in these capsules was obtained from cattle (n = 51), pigs (n = 31), or both (n = 44). In our previous study, we found that plant-specific products were amplified from the capsules that were labeled to contain gelatin as well as fish gelatin; these plant sources originated from the various plant-derived materials used

Table 1. Primers used in this study

Species	Primer	Target gene	Sequence (5' to 3')	T _m (°C)	Size (bp)	Reference
Bovine	SFI11-Cow-F	<i>16S rRNA</i>	TATCTTGAAGCTAGACCTAGCCCAATG	56.1	131	Lee et al., (2016)
	SFI11-Cow-R		GGTACTTTCTCTATAGCGCCGTAC	54.6		
Porcine	SFI11-Pig-F	<i>16S rRNA</i>	CAACCTTGACTAGAGAGTAAAACC	54.4	138	
	SFI11-Pig-R		GGTATTGGGCTAGGAGTTTGTT	57.7		
Fish	F16-F1	<i>16S rRNA</i>	TAATAAACAAATAAGAGGTCCCG	51.4	151	
	F16-R1		GGAGACAGTTAAGCCCTCGTCAT	57.4		
Plant	PR-F2	<i>rbcL</i>	GATTCGCAAATCTTCCAGACG	56.0	255	
	PR-R2		TCTTCTACTGGTACATGGACAAC	51.3		

Table 2. Identification of raw materials of gelatin capsules by species-specific PCR

No.	Brief description of the capsule content	Country of manufacture	Label information	Gelatin origin by species-specific PCR			
				bovine	porcine	fish	plant
1	Enzyme	U.S.A.	Gelatin	+	+	-	+
2	Fenugreek seed	U.S.A.	Gelatin	-	+	-	+
3	Bioflavonoids	U.S.A.	Gelatin	+	+	-	+
4	Pantothenic acid	U.S.A.	Gelatin	+	+	-	+
5	Methylsulfonylmethane	U.S.A.	Gelatin	+	+	-	+
6	Propolis	U.S.A.	Gelatin	-	+	-	+
7	Propolis	Canada	Gelatin	+	-	-	-
8	Zinc	U.S.A.	Gelatin	-	+	-	+
9	Biotin	U.S.A.	Gelatin	+	+	-	+
10	Cranberry	U.S.A.	Gelatin	-	+	-	+
11	Zinc	U.S.A.	Gelatin	-	+	-	+
12	Propolis	U.S.A.	Gelatin	+	+	-	+
13	Lutein	Canada	Gelatin	+	-	-	+
14	Shark Cartilage	U.S.A.	Gelatin	+	+	-	+
15	Gamma Linoleic Acid	U.S.A.	Gelatin	+	-	-	-
16	Colostrum	U.S.A.	Gelatin	+	-	-	+
17	Apple pectin	U.S.A.	Gelatin	+	+	-	-
18	Primrose oil	U.S.A.	Gelatin	+	-	-	-
19	Pribiotic	U.S.A.	Gelatin	+	-	-	+
20	Inositol	U.S.A.	HPMC ⁽¹⁾	-	-	-	+
21	Omega	Norway	Gelatin	+	-	-	+
22	Estrogen	U.S.A.	Gelatin	+	-	-	+
23	Vitamin E	U.S.A.	Gelatin	+	-	-	+
24	White Kidney Bean	U.S.A.	Gelatin	+	-	-	+
25	Gamma-Aminobutyric Acid	U.S.A.	Gelatin	+	+	-	+
26	Devil's claw	U.S.A.	Gelatin	+	+	-	+
27	ACAI	U.S.A.	Gelatin	+	-	-	-
28	L-Ornithine	U.S.A.	Gelatin	+	+	-	+
29	Vitamin B6, B12	U.S.A.	Gelatin	+	-	-	+
30	Taurine	U.S.A.	Gelatin	+	+	-	+
31	Ginger	U.S.A.	Gelatin	+	+	-	-
32	Thiamin	U.S.A.	Gelatin	+	+	-	-
33	Gamma Linoleic Acid	U.S.A.	Gelatin	+	-	-	+
34	Flax oil	U.S.A.	Gelatin	+	+	-	+
35	Glucosamine	U.S.A.	Gelatin	+	-	-	+
36	Collagen	U.S.A.	Marine Gelatin	-	-	+	-
37	Essential enzymes	U.S.A.	Gelatin	+	+	-	+
38	Primrose oil	U.S.A.	Gelatin	+	-	-	-
39	Ho Shou Wu	U.S.A.	Gelatin	+	+	-	+
40	Krill oil	U.S.A.	Gelatin	+	-	-	-
41	Bilberry	U.S.A.	Gelatin	+	+	-	+

Table 2. (Continued) Identification of raw materials of gelatin capsules by species-specific PCR

No.	Brief description of the capsule content	Country of manufacture	Label information	Gelatin origin by species-specific PCR			
				bovine	porcine	fish	plant
42	Ginkgo biloba extract	U.S.A.	Gelatin	+	+	-	+
43	Vitamin A	U.S.A.	Gelatin	-	+	-	-
44	Flax seed oil	U.S.A.	Gelatin	-	+	-	-
45	Coenzyme Q10	U.S.A.	Gelatin	+	+	-	-
46	Coenzyme Q10	U.S.A.	Gelatin	+	+	-	-
47	Royal Jelly	U.S.A.	Gelatin	+	+	-	+
48	Primrose oil	U.S.A.	Gelatin	+	-	-	+
49	Fish oil	U.S.A.	Gelatin	-	+	-	-
50	Propolis	U.S.A.	Gelatin	+	+	-	-
51	Coconut oil	U.S.A.	Gelatin	+	+	-	+
52	Primrose oil	Norway	Gelatin	+	-	-	-
53	Cranberry	U.S.A.	Gelatin	+	+	-	-
54	Aphanizomenon Flos-aquae	U.S.A.	Vegetarian Capsules	-	-	-	+
55	Vitis vinifera	U.S.A.	Vegetable Cellulose	-	-	-	+
56	Lutein	U.S.A.	Gelatin	+	+	-	+
57	Omega-3	Canada	Gelatin	+	+	-	+
58	Omega-3	U.S.A.	Modified Food Starch	-	-	-	+
59	Aged Garlic Extract	U.S.A.	Gelatin	+	-	-	-
60	Calcium	U.S.A.	Gelatin	+	+	-	+
61	Lutein	Canada	Gelatin	+	-	-	+
62	Calcium	U.S.A.	Gelatin	+	-	-	-
63	Magnesium	U.S.A.	Gelatin	-	+	-	-
64	Soy extract	U.S.A.	Gelatin	+	-	-	+
65	L-Ornithine	U.S.A.	Gelatin	+	+	-	+
66	Vitamin E	U.S.A.	Gelatin	+	-	-	+
67	Methylsulfonylmethane	U.S.A.	Gelatin	+	+	-	+
68	Fish oil	U.S.A.	Gelatin	+	-	-	+
69	Omega 3	Canada	Fish Gelatin	-	-	+	+
70	Coenzyme Q10	U.S.A.	Gelatin	+	-	-	+
71	Vitamin D3	U.S.A.	Gelatin	+	-	-	-
72	Colostrum	U.S.A.	Gelatin	+	-	-	-
73	Omega 3	Norway	Gelatin	+	-	-	-
74	Gamma-Aminobutyric Acid	U.S.A.	Vegetable Cellulose	-	-	-	+
75	Coenzyme Q10	U.S.A.	Gelatin	+	-	-	-
76	Vitamin B	U.S.A.	HPMC ⁽¹⁾	-	-	-	+
77	Vitamin E	U.S.A.	Modified Food Starch	-	-	-	+
78	Vitamin C	U.S.A.	HPMC ⁽¹⁾	-	-	-	+
79	Iron	U.S.A.	HPMC ⁽¹⁾	-	-	-	+
80	Acetyl-L-Carnitine	U.S.A.	Vegetarian Capsules	-	-	-	+
81	L-Arginine	U.S.A.	Gelatin	-	+	-	-
82	L-Leucine	U.S.A.	Gelatin	-	+	-	-

Table 2. (Continued) Identification of raw materials of gelatin capsules by species-specific PCR

No.	Brief description of the capsule content	Country of manufacture	Label information	Gelatin origin by species-specific PCR			
				bovine	porcine	fish	plant
83	Propionyl-L-Carnitine	U.S.A.	Gelatin	+	-	-	-
84	Safflower Seed Oil	U.S.A.	Gelatin	+	+	-	-
85	L-arginibe hydrochloride	U.S.A.	Vegetarian Capsules	-	-	-	+
86	Wild Maca Root	Canada	Vegetarian Capsules	-	-	-	+
87	Vitamin C	Canada	Vegetable Cellulose	-	-	-	+
88	Sabal Fruits	Canada	Vegetarian Capsules	-	-	-	+
89	Green Coffee Bean	Canada	Gelatin	+	+	-	-
90	Vitamin C	U.S.A.	Vegetarian Capsules	-	-	-	+
91	Erythralum scandens ethanolic extract	U.S.A.	Gelatin	+	-	-	+
92	Green Coffee Bean	U.S.A.	Gelatin	-	+	-	-
93	Calcium	U.S.A.	Gelatin	+	+	-	-
94	Royal Jelly	U.S.A.	Gelatin	+	-	-	-
95	Vitamin A	U.S.A.	Vegetarian Capsules	-	-	-	+
96	Niacin	U.S.A.	Gelatin	+	+	-	+
97	Magnesium	U.S.A.	Vegetarian Capsules	-	-	-	+
98	L-Carnitine HCL	U.S.A.	Gelatin	-	+	-	+
99	D-Aspartic Acid	U.S.A.	Gelatin	-	+	-	+
100	Safflower seed Oil	U.S.A.	Gelatin	+	-	-	-
101	Magnesium	U.S.A.	Gelatin	+	-	-	-
102	Magnesium	U.S.A.	Gelatin	+	+	-	-
103	Dietary Fiber	U.S.A.	Gelatin	+	-	-	+
104	Butea Superba(Root)	U.S.A.	Gelatin	+	-	-	+
105	L-Tyrosine	U.S.A.	Gelatin	-	+	-	-
106	Opuntia ficus indica	U.S.A.	Vegetarian Capsules	-	-	-	+
107	Propolis	U.S.A.	Veggie Capsules	-	-	-	+
108	Acetyl-L-Carnitine	U.S.A.	Veggie Caps	-	-	-	+
109	Vitex Fruit	U.S.A.	Vegetarian Capsules	-	-	-	+
110	Grape Seed Extract	U.S.A.	Veggie caps	-	-	-	+
111	Vitamin E	U.S.A.	Vegetarian softgels	-	-	-	+
112	Garlic oil Extract	U.S.A.	100% Bovine gelatin	+	-	-	-
113	Papaya fruit powder	U.S.A.	Gelatin	-	+	-	+
114	Vitamin E	U.S.A.	100% Bovine gelatin	+	-	-	-
115	Fish oil	U.S.A.	100% Bovine gelatin	+	-	-	-
116	Coenzyme Q10	U.S.A.	100% Bovine gelatin	+	-	-	+
117	Eicosapentaenoic Acid Ethyl Ester	U.S.A.	Gelatin (Bovine)	+	-	-	+
118	Eicosapentaenoic Acid Ethyl Ester	U.S.A.	Gelatin (Bovine)	+	-	-	+
119	Vitamin E	U.S.A.	Gelatin (Bovine)	+	-	-	+
120	Caralluma fimbriata	U.S.A.	Gelatin	+	+	-	+
121	Biotin	U.S.A.	Gelatin	+	+	-	+
122	Vitamin B6	U.S.A.	Gelatin	-	+	-	+
123	Theacrine	U.S.A.	Gelatin	-	+	-	+

Table 2. (Continued) Identification of raw materials of gelatin capsules by species-specific PCR

No.	Brief description of the capsule content	Country of manufacture	Label information	Gelatin origin by species-specific PCR			
				bovine	porcine	fish	plant
124	Guarana Extract	U.S.A.	Gelatin	+	+	-	+
125	Vitamin B12	U.S.A.	Gelatin	+	+	-	+
126	Taurine	U.S.A.	Gelatin	+	+	-	+
127	Citrus Extract	U.S.A.	Gelatin	+	+	-	+
128	Green tea Extract	U.S.A.	HPMC ¹⁾	-	-	-	+
129	Cacao Extract	U.S.A.	Gelatin	+	+	-	+
130	Green tea Extract	U.S.A.	Gelatin	+	+	-	+
131	Dandelion Root Extract	U.S.A.	Vegetable Capsule	-	-	-	+
132	Vitamin B12	U.S.A.	Gelatin (Bovine)	+	-	-	+
133	Folic Acid	U.S.A.	Plant cellulose	-	-	-	+
134	Saw Palmetto	Korea	Gelatin	+	-	-	-
135	Milk Thistle	U.S.A.	Cellulose capsule	-	-	-	+
136	Acetyl-L-Carnitine	U.S.A.	Vegetarian capsule	-	-	-	+
137	Green tea Extract	U.S.A.	Vegetarian capsule	-	-	-	+
138	Tribulus terrestris	U.S.A.	Gelatin	+	-	-	-
139	Green coffee bean	U.S.A.	HPMC ¹⁾	-	-	-	+
140	Calcium β -hydroxy- β -methylbutyrate	U.S.A.	Gelatin	+	-	-	+
141	Magnesium	U.S.A.	Kosher Gelatine	+	-	-	-
142	Zinc	U.S.A.	Gelatin	-	+	-	+
143	Zinc	U.S.A.	Gelatin	-	+	-	+
144	Maca	U.S.A.	Gelatin	-	+	-	-
145	Milk Thistle	U.S.A.	Gelatin	-	+	-	-
146	Calcium	U.S.A.	Gelatin	+	-	-	-
147	Raspberry Ketone Powder	U.S.A.	Gelatin (Bovine)	+	-	-	+
148	Inositol	U.S.A.	Gelatin (Bovine)	+	-	-	+
149	Fenugreek seed Extract	U.S.A.	Gelatin	-	+	-	-
150	Cowhage Extract	U.S.A.	Gelatin	+	-	-	+
151	Ashwagandha Extract	U.S.A.	Gelatin	+	-	-	-
152	Maca	U.S.A.	Gelatin	+	-	-	+
153	Coleus forskohlii root	U.S.A.	Gelatin	+	-	-	+
154	Maca	U.S.A.	Gelatin	+	-	-	+
155	Vitamin E	U.S.A.	Gelatin	+	-	-	+
156	Chrysin	U.S.A.	Vegetarian capsule	-	-	-	+
157	Garcinia indica extract	U.S.A.	Gelatin	-	+	-	+
158	Maca	U.S.A.	HPMC ¹⁾	-	-	-	+
159	Citrus aurantium	U.S.A.	Vegi capsules	-	-	-	+
160	Vitamin E	U.S.A.	Gelatin	-	+	-	+
161	Fucoanthin Extract	Canada	Halal and kosher gelatin capsules	-	-	-	+
162	Dandelion	Canada	Halal and kosher gelatin capsules	-	-	-	+
163	Raspberry Ketone	U.S.A.	Gelatin	-	+	-	+

Table 2. (Continued) Identification of raw materials of gelatin capsules by species-specific PCR

No.	Brief description of the capsule content	Country of manufacture	Label information	Gelatin origin by species-specific PCR			
				bovine	porcine	fish	plant
164	Green Tea Leaf Extract	U.S.A.	Vegetable capsule	-	-	-	+
165	Coleus forskohlii Extract	U.S.A.	Gelatin	+	-	-	+
166	Garcinia cambogia Extract	U.S.A.	Gelatin	+	-	-	+
167	Magnesium	U.S.A.	Gelatin	+	-	-	+
168	Tongkat Ali	U.S.A.	Gelatin (Bovine)	+	-	-	+
169	Homy Goat weed Extract	U.S.A.	Gelatin	-	+	-	+
170	Omega-3	U.S.A.	Gelatin	-	+	-	-
171	Omega-3	U.S.A.	Gelatin	-	+	-	+
172	Caffeine Anhydrous	U.S.A.	Gelatin	+	-	-	+
173	Cissus quadrangularis	U.S.A.	Vegetarian capsule	-	-	-	+
174	Green Coffee	U.S.A.	Gelatin	-	+	-	+
175	Medicago sativa	U.S.A.	Gelatin	+	-	-	+
176	Vitamin B12	U.S.A.	Gelatin (Bovine)	+	-	-	+
177	Caffeine Anhydrous	U.S.A.	Gelatin	+	+	-	+
178	Garcinia cambogia	U.S.A.	Kosher capsule	-	-	-	+
179	Green Tea	U.S.A.	Vegetarian capsule	-	-	-	+
180	Proprietary enokitake mushroom	U.S.A.	Vegicaps	-	-	-	+
181	Maca	U.S.A.	Gelatin	-	+	-	+

¹⁾ HPMC : hydroxypropyl methylcellulose

during the capsule manufacturing process, such as plasticizers to help produce the capsule shape⁸⁾.

Gelatin is a popular ingredient (e.g., as a gelling and foaming agent) in the food industry and is widely used in the manufacturing of hard and soft capsules in the pharmaceutical industry^{2,3)}. The global market size for gelatin was 412,700 tons in 2015, which is largely attributed to consumption in food & beverage and pharmaceutical applications, accounting for 29.0% and 20.7% of the global volume in 2015, respectively⁹⁾. In Europe, approximately 80% of the edible gelatin is produced from pure pig skin, 15% comes from cattle hide split, and the remaining 5% comes from pig and cattle bones as well as fish¹⁰⁾. Therefore, strong concerns remain among consumers with religious beliefs that proscribe the consumption of certain food items. For example, Judaism and Islam forbid the consumption of porcine products, whereas Hindu customs do not permit the consumption of bovine products. In addition, Buddhists are strict vegetarians and are prohibited from eating mammalian products⁵⁻⁷⁾. Therefore, the identification of the raw materials used to make gelatin is critically important from a regulatory point of view and will help instill confidence in the end user. Although the food labeling regulations of South Korea make it compulsory to declare all raw materials or ingredients on

the labels of packaged foods in an accurate and transparent manner¹¹⁾, determining the origin of commercially available gelatin is still a challenge owing to the multiple processing and purification steps involved in its production. In this study, we did not observe any cases of mislabeling or substitution of the source of gelatin in the capsules. However, among the capsules analyzed in this study, only 30% declared that bovine-, fish- or plant-derived gelatin was used. The majority (70%) of dietary supplement labels did not specify the species used as the raw material for gelatin production. Such inadequate labeling would result in serious consequences such as violation of religious beliefs and health concerns (e.g., bovine spongiform encephalopathy). With respect to religious faiths, it is particularly important to inform consumers about products that might contain traces of pork and/or beef on the labels. Therefore, we suggest that capsules labeled with simply the item “gelatin” without identifying the source of the protein should further declare the raw material used to best protect consumers’ rights and religious beliefs. Providing sufficient information about the source of gelatin would likely boost consumers’ trust in gelatin-based products, especially in the vegetarian, halal, and kosher markets, which in turn can promote the industry.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

국문 요약

상업적으로 유통되는 젤라틴 캡슐 제품은 소비자의 건강(예: 광우병) 및 종교적 신념에 대한 우려를 야기시킬 수 있다. 젤라틴은 대부분 소, 돼지 등에서 유래한 원료 물질을 가공한 것으로서, 가공 후 그 원료 물질을 분석하는 것은 대단히 어렵다. 따라서 정부 규제기관의 표시사항 준수여부 모니터링 연구가 주기적으로 필요하다. 본 연구에서는 인터넷에 유통되는 건강기능식품(n = 181)을 대상으로 젤라틴 캡슐의 원료 물질을 중 특히 PCR 방법으로 분석했다. 55개 제품의 경우 표시사항에 젤라틴 캡슐 원료 물질에 대한 정보를 명시하였으나(예: bovine-, fish- and plant-derived gelatin), 126개 제품의 경우 사용 원료에 대한 정보 없이 “gelatin”으로 표시하였다. 이 126개 제품의 젤라틴 캡슐 분석 결과 51개 제품은 소 유래의 젤라틴을, 31개 제품은 돼지 유래의 젤라틴을, 그리고 44개 제품은 소와 돼지의 원료를 혼합하여 제작한 블렌딩 젤라틴을 사용한 것으로 밝혀졌다. 따라서 소비자의 알 권리, 종교적 신념 및 건강을 보호하기 위해 젤라틴 캡슐에 사용된 원료 물질을 표시사항에 제공하는 것은 매우 중요하다.

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