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Review

A Current Review on Buckwheat: Historical Aspects of its Utilization in China and Japan, and Its Contribution to Human Nutrition

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ABSTRACT

This paper was undertaken to review two following points regarding buckwheat: firstly historical aspects of its utilization in China and Japan; and secondly, its contribution to human nutrition.

INTRODUCTION

Life-style diseases such as diabetes mellitus, dyslipidemia, heart diseases and hypertension, are a current, major nutritional problem globally. Prevention of these diseases is a research subject of much interest in nutrition science. Increasing attention on food constituents which may be effective for preventing such lifestyle diseases, is currently paid. The Ministry of Health, Labour and Welfare, Japan (MHLWJ, 2021) proposes that people will actively play a role at their social parts in 100-years old era. In relation to this, great interest is paid to the intakes of diets or foods with nearly perfect nutritional composition from the viewpoint of taking foods with well-balanced nutrients. Furthermore, food ingredients, if any, associated with longevity might be focused to the characterization of such food ingredients.

Buckwheat has been used in many countries for a long time (Ikeda 2002; Kreft et al., 2003). There is a variety of buckwheat foods produced on a global basis (Ikeda, 2002). However, there are unanswered subjects regarding the historical facts of utilization of buckwheat, especially in China and Japan.

Buckwheat food is rich in nutrition, and excellent in palatability. It is important to clarify nutritional characteristics of buckwheat. It is necessary not only to investigate the nutritional characteristics of buckwheat but also to elucidate factors responsible for its palatability.

This paper review two following points: firstly, historical facts of buckwheat utilization in China and Japan; and secondly, contribution of buckwheat to human nutrition including palatability.

1) HISTORY OF BUCKWHEAT UTILIZATION

1-1 History in China

It is known that China may be the birthplace of cultivation of buckwheat (Ohnishi, 2001 and 2003). Buckwheat (*Fagopyrum* spp.) spread to Europe and Russia via some roads such as the Silk Roads, and also spread to Korea and Japan. In prehistorical times in China, it has been thought that buckwheat plants existed as a spontaneous crop for many wild forests in some regions, such as Shandong, Guizhou and Yunnan provinces and the Sichuan heights in China. Buckwheat pollen was found in the sediments from about 5,000 years ago in Inner Mongolia Region.

The world-first Chinese anthology, "Shi-Ji" was written in the BC 11th century. It is estimated that this Chinese anthology may be comparable, as the worldwide oldest anthology, to "Iliad" and "Odyssea" which were written on BC 8th century by the famous Greek minstrel Homer. The anthology "Shi-Ji" describes that buckwheat was cultivated about 3500 years ago during the Yin dynasty (BC 17th century to BC 1046), which was the first dynasty of China. The book "Shi-Ji" also describes that "the Emperor Huang-Di" (BC 2510-2448), who first unified China, was often eating buckwheat noodles with porcine meats and mutton meats after heating.

Descriptions about buckwheat were found in another famous anthology written in the Zhou Dynasty (BC 256-1046). Zheng et al. (2003) described the importance of buckwheat utilization in "Qi-Min-Yao-Shu", edited on AD 532-549, which means complete agriculture works. In Japan, the famous agricultural book "Qi-Min-Yao-Shu" was widely utilized. At that time, there were many highly-educated intellectual Japanese people. They were able to understand many books written in Chinese language, such as the book "Qi-Min-Yao-Shu". They largely contributed to cultural exchanges with China. Buddhism, which happened in India and deeply affected Japanese culture later, was introduced to Japan in AD 552, through China.

It was reported that buckwheat was eaten as its noodles 4000 years ago in China. Carbonated buckwheat seeds, which were harvested in BC 2nd to 3rd century, are exhibited in Xian Archaeological Museum. The famous poet, Bai Juyi (AD 772-846), was born in Taiyuan, Shanxi Province. His famous poem is well-known in China and also Japan, i.e., "The moon is lightening in buckwheat field, and buckwheat flowers are blooming as like snowing" (AD 812) (Tenchi Em., 720). Then buckwheat foods, especially buckwheat noodles, become gradually popular in China.

There is an ethnic minority people called Yi people in China. They live mainly in Yunnan and Sichuan provinces. The minority peoples, who may begin the cultivation of buckwheat (Ohnishi, 2001 and 2003), have two different pictograms distinguishing between common buckwheat and Tartary buckwheat. Tartary buckwheat in particular is said to be very precious food to give to God of Yi people. Because Tartary buckwheat has a bitter taste (the bitterness comes from resolvent quercetin from rutin) for the word "Tartary buckwheat". As Tartary buckwheat have special implication, in China, Chinese people usually say ku-cho.

There is Mian culture in China and Japan, whereas there is Pasta culture in Europe including Italy. Mian in China and pasta in Europe are closely similar to each other. Both foods are made from cereal flour, including wheat flour and other cereal flour, such as buckwheat. In view of food cultural science, it is interesting that the form of each resultant product made from wheat flour are similar to each other. For example, orecchiette in Europe, including Italy and France, means earlobe, whereas ma-erdou in China means a pretty pasta such as cat's earlobe. For another example, conchiglie in Italy means a pasta like shell-shape, whereas Chao-mai-ke in China means a shell-shaped buckwheat pasta. Although each origin and birthplace of pasta and mian is very interesting, the detailed information remains an important subject of controversy.

In China, there is a folks saying "rice in south, whereas mian in north" (Zhou, 1988). This legend conveys that rice has been utilized in the southern region, whereas wheat, i.e., mian, has been utilized in the northern region. Mian originally meant wheat flour, whereas the word "bing" means products made from wheat flour (mian). Later mian wholly means wheat products and wheat products as the general term. Mian culture has been developed and established from the Tang Dynasty (AD 618-907) to the Song Dynasty (AD 960-1279) (Zhou, 1988; Okada, 1993).

The book entitled "Ethnobotany of Buckwheat" (ed. by Kreft et al.) was published in 2003. This book affords the history and various utilization of buckwheat in many countries. We hope that this book will be more and more completed in the future.

1-2 History in Japan

Buckwheat spread to Japan via some sea coast regions from Kyushu to Hokkaido (Ujihara, 2007) and Tsushima Island, Japan's coast regions via the Korean Peninsula (Ujihara and Matano, 1978).

Pollen analysis showed that the pollen of buckwheat flowers was found about 6600 years ago (Tsukada, 1976). Prof. Tsukada (New Yolk State Univ.) described that buckwheat pollen was found about 6600 years ago, but after that no pollen was found until AD 5th century. He suggested that buckwheat was cultivated by the slash-and-burn method from about BC 5th century to AD 5th century until pollen was not found during this period. Entering AD 5th century, large-scale farming of buckwheat was started (Tsukada, 1976). The oldest description of buckwheat in Japan was found on AD 744 (The 44 Emperor "Shoku-Nihon-Gi (Shoku (Sequel) Nihon (Japan) Gi (Record))". The famous Japanese encyclopedia "Wamyo-Ruiji-Sho" (ed. by Mr. Shitago Minamoto on AD 931-938), showed that buckwheat was already a popular food at that time.

Buckwheat noodles are a popular food in Japan (JBA, 2023). The first document recording that buckwheat was processed to noodles was found in AD 1572 (Niijima and Satsuma, 1985). Prof. Shigeo Miwa (Doshisya Univ.) described that the oldest discovery of a stone mill (Ishi-usu) was about AD 1220 in Japan. The Miwa's estimate on Ishi-usu (stone-mill) shows that the processing technology of buckwheat noodles may have been born after the discovery of Ish-usu in Japan, maybe at the beginning of 14th century. In this connection, several famous Priests such as Priest Dougen and Priest Yousai, who actively promoted Buddhism on the beginning of the 14th century, set up new Buddhism, i.e., Zen-shu, respectively. The Priests often visited China to learn on Chinese Buddhism. It is thought that they spread the processing technology of buckwheat noodles in China. The oldest buckwheat store, Owari-ya, was built in AD 1465 in Kyoto. This shop started with making of buckwheat confectionaries and later started making noodles. This description is written with the consent of the Owari-ya. The oldest document on buckwheat noodles was found in Jyosyou-ji Temple (Nagano-prf) document (AD 1574). The oldest book about the cookery procedure of buckwheat noodles was found "Ryori-Monogatari", which means cookery story (AD 1643). From around this time, buckwheat noodles may be popular foods in Japan. The utilization of buckwheat noodles is described later in subchapter (2-5) on beri-beri and buckwheat.

2) CONTRIBUTION OF BUCKWHEAT TO HUMAN NUTRITION

2-1 The major constituent, protein, in buckwheat flour, is characterized by high-content, well-balanced essential amino acids, resistant protein, gluten-free protein.

Buckwheat flour contains a high level of proteins: this flour has the highest protein among cereals usually used (STFCJ, 2020). Protein quality is generally judged from two points, i.e., amino acid score and digestibility. The amino acid score of buckwheat is 100, considered on

FAO/WHO/UNU amino acid standard (2007), meaning less or substantially no shortage on essential amino acid is found in buckwheat flour. On the other hand, buckwheat exhibits low protein digestibility in human (STFCJ, 1982). This finding suggests that buckwheat protein is a resistant protein, which exhibits resistance to gastrointestinal digestion. Comparison with other proteins showed that buckwheat protein belongs to resistant proteins with low digestibility (Ikeda and Kishida, 1993). Resistant proteins were reported with soybean (Azuma et al., 2000) and digestion after high amylose-corn starch (Morita et al., 1998). It is shown that consumption of buckwheat protein lowers plasma cholesterol and raises fecal neutral sterols in cholesterol-fed rats because of its lower digestibility (Kayashita et al., 1997), although there are many unanswered points. Furthermore, buckwheat contains no gluten, so buckwheat has characteristics of a gluten-free protein source.

2-2 Major constituent, available carbohydrate in buckwheat flour is characterized by low glycemic value and resistant starch.

Increasing attention is currently paid to glycemic index. Buckwheat noodles are known to exhibit a low glycemic index (GI) (Sugiyama, 2000). Buckwheat noodles exhibit approximately 56 of GI value, whereas polished rice, 100; and wheat bread, 92 (Sugiyama, 2000). On the other hand, buckwheat flour and groats contain highly digestion resistant starch compared to those of other plant foods (Kreft et al., 1996; Kreft et al., 2020). The observed low glycemic index may be closely associated with the high content of resistant starch and high dietary fiber described later.

2-3 Major constituent, unavailable carbohydrate, i.e., dietary fiber, is characterized by high content, high insoluble dietary fiber, possibly lowering effect on the onset of life-styled diseases.

Buckwheat flour contains dietary fiber at a high level (STFCJ, 2020). Meta-analysis (MHLWJ, 2020) showed that the intake of dietary fiber significantly exhibits negative correlations to the following eight items or diseases;

1) the total mortality;
2) the onset and mortality rate of myocardial infarction;
3) the onset of stroke;
4) the onset and mortality rate of circulatory diseases;
5) the onset of type 2 diabetes;
6) the onset of breast cancer;
7) the onset of stomach cancer; and
8) the onset of colorectal cancer.

Dietary fiber is an attractive ingredient that cures the above diseases and reduces total mortality. Buckwheat flour contains a higher level of dietary fiber compared with other cereals; buckwheat flour contains approximately 9 times more dietary fiber than polished rice and approximately 1.8 times more than wheat flour (STFCJ 2020). We showed that the major dietary fiber was present as insoluble form in buckwheat flour (Skrabanja et al., 2004). Dietary fiber in buckwheat flour meets approximately 25% of the daily needs of women aged 30 to 49 (MHLWJ 2020; STFCJ 2020). Buckwheat is an excellent source of dietary fiber.

On the other hand, Li et al. (2018) investigated, using random-effects models, relationship between buckwheat and cardiovascular disease risk: buckwheat intervened total cholesterol, triglyceride. These effects may be closely associated with dietary fiber.

2-4 Buckwheat flour is characterized by the presence in flour of various trace constituents, minerals, and vitamin.

Buckwheat flour contains various kinds of minerals and vitamins at high levels. It is known that 13 minerals are essential for humans (MHLWJ, 2020). Among the 13 minerals, buckwheat flour (100 g edible portion, 100EP abbreviated) (STFCJ, 2020) exhibited nutritional contribution (%) satisfy the required dietary reference intakes (MHLWJ, daily required nutritional intakes of 30 to 49 years old women or males, DRNI abbreviated) by 100 g buckwheat flour. Our estimation shows that buckwheat flour is important source of nine minerals, i.e., Mn (100, 100), Cu (77, 60), Mg (66, 51), P (50, 40), Cr (40, 40), Fe (27, 37), Mn (31, 27), Se (28, 23), and Zn(30, 22), in order of magnitude of nutritional contribution, as minerals with 20% or over of DRNI from 100EP (MHLWJ, 2020; STFCJ, 2020). The numbers in front in parentheses indicate % nutritional contribution to females 30-49 years old; and numbers in back, % nutritional contribution to males 30-49 years old.

Buckwheat flour also contains various kinds of vitamins in a high level. It is known that 13 vitamins are essential for humans (MHLWJ, 2020). In addition to minerals, our estimation shows that buckwheat flour is important source of six vitamins, i.e., niacin (64, 51), vitamin B_1(41, 33), biotin (34, 34), pantothenic acid

(31, 31), vitamin B_6 (27, 21) and folic acid (21, 21), in order of magnitude of nutritional contribution, as vitamins with 20% or over of DRNI from 100EP (MHLWJ, 2020; STFCJ, 2020). Numbers in front in parentheses indicate % nutritional contribution to females 30-49 years old; and numbers in back, % nutritional contribution to males 30-49 years old.

2-5 Beri-beri and buckwheat.

In relation to vitamin B_1, Japanese people have had rice as staple food since about 3,000 years ago after introducing rice from India, China etc. to Japan. Japanese people had rice as brown rice with bran. Since 420 years ago, Japan has stabilized given political and economic conditions. Many people, especially upper echelons, had white rice without bran. People who had white rice without bran got certain disease, called EDO (the old name of Tokyo)-WAZURAI (means disease). In Today's science, EDO-WAZURAI is beri-beri, which is caused by the deficiency of vitamin B_1. Beri-beri was once the main disease in Japan. Rice bran contains a high level of vitamin B_1, but white rice contains less or no vitamin B_1. The STFCJ 2020 shows that 100 g polished rice contains 0.02 mg of vitamin B_1; 100 g brown rice, 0.41 mg; and 100 g buckwheat flour, 0.46 mg. However, people with beri-beri after leaving Edo (Tokyo), they went back to their country-side, where they had buckwheat etc, they cured beri-beri entirely in a few days. It was reported (Fujimaki, 1924) that many people gradually became aware of the curing effect of buckwheat against beri-beri. Today, Japanese people, especially people in Tokyo, like to eat buckwheat noodles. Tradition of healing from beri-beri may be the main reason why Japanese people, especially people in Tokyo, love buckwheat noodles. In this development, the concept 'vitamin' was established by the great scientists U. Suzuki, C. Funk, C. Eijkman and F.G. Hopkin (AD 1911-1929).

2-6 Buckwheat and Buddhist practice: Can humans live only on buckwheat and some vegetable?

The 2nd International Symposium on buckwheat was held at Miyazaki University, Japan in 1983. In the symposium, the great Buddhist C. Hagami (Enryaku-ji Temple in Mt. Hiei) had a lecture entitled "Buckwheat and Buddhist practice". Many people were deeply moved by his lecture.

Many Japanese people believe in Buddhism. In Japan there are various types of temples where Buddhist training practices for Buddhist are carried out. Among Buddhist training practices, there is famous Buddhist practice in Enryaku-ji Temples in Mt. Hiei where straddles between Kyoto and Shiga, The Buddhist practice is called "1000-day practice". The Buddhist practice are implemented over approximately 7 years. For 100 days after the 7 years-practice, person practicing does not eat five cereals, i.e., rice, wheat, millet, soybean and barnyard millet, they are as well without salt, fruits and sea vegetables for 100 days. Only two foods, i.e., buckwheat and some vegetable, are allowed for these 100 days. Can human live only on buckwheat and some vegetable?

Nutritional implications will be presented: buckwheat flour has a well-balanced amino acid composition comparable to eggs and beef meat. Buckwheat flour also contains a lot of starch which is an energy source. In view of vitamin nutrition, buckwheat flour contains various vitamins but except few vitamins, i.e., A, D, K, B_{12} and C. Among the vitamins, A and C can be supplied from vegetables. Certain amount of vitamin D can be synthesized from 7-dehydro-cholesterol in human skin. Vitamins K and B_{12} can be synthesized from micro-flora in our colon. There is no problem with vitamins in such nutrition. Therefore, we can conclude that humans can live by ingesting just buckwheat and vegetables. But, there is a possibility indicating that dietary life without salt and sea vegetables may lead to mild NaCl and iodine-deficiency. Interesting enough, thus, Japanese Buddhist Practice shows nutritional characteristics of buckwheat flour. Although buckwheat is not a perfect food, great interest is paid to buckwheat as a food with near-perfect ingredients for humans from the perspective of taking well-balanced nutrients.

2-7 Polyphenols

Common buckwheat flour contains 7 to 20 mg of rutin and approximately 1 mg of quercetin; Tartary buckwheat flour contains 1200 to 1500 mg rutin and approximately 100 mg quercetin, respectively (Asami et al., 2007).

Rutin, a flavonol-type flavonoid with rutinoside on 3'-position of B ring, is a representative polyphenol found in buckwheat. While flavonoid glycoside is generally deglycosylated in the small intestine by lactase-phlorizin hydrolase (LPH) or β-glucosidase, rutin is absorbed into the circulation slowly (Hollman et al., 1997; Crespy et al., 1999). This is because rutin is not substrate for LPH, and therefore it cannot be digested in the small intestine. Instead, rutin is hydrolyzed to quercetin aglycone by intestinal microflora in the large intestine. Part of quercetin aglycone is further converted into various phenolic acids, such as 3,4-dihydroxyphenylacteic acid (DOPAC), 3-hydroxyphenylacetic acid (OPAC) and vanillic acid, by intestinal microflora, and excreted in urine (Baba et al., 1983; Mullen et al., 2008; Makino et al., 2009). The rest is directly absorbed in the large intestine and entered enterohepatic circulation. The absorbed quercetin aglycone is then metabolized into various conjugates, such as glucuronides and sulfates, by phase II enzymes. In previous studies were detected quercetin-3-glucuronide, quercetin-3'-sulfate, and 3'-methyl-quercetin-3-glucuronide in human blood and lymph, and these metabolic conjugates circulate in the intestine, or are excreted in the bile and urine (Mullen et al., 2006; Murota et al., 2003).

Several studies have demonstrated biological effects of metabolites. It is reported that quercetin aglycone shows various biological activities, such as antioxidation, anti-inflammatory, anti-bacterial, anti-tumor, and anti-angiogenic activity (Yang et al., 2020; Kleemann et al., 2011; Park et al., 2008). Quercetin aglycone is completely metabolized to conjugates. Shimoi et al. (2000; 2001) reported that quercetin aglycone could exhibit various effects, such as antioxidant, anti-cancer and anti-inflammatory effects, at the inflammation site; it is probably because β-glucuronidase released from the inflammatory cells hydrolyze quercetin glucuronide into quercetin aglycone (Shimoi et al., 2000; Shimoi et al., 2001). So, it could show that quercetin aglycone has various effects on the inflammation site. We also showed that quercetin-3-glucuronide is passed through the endothelium to the smooth muscle cells (SMCs) at the time of inflammation (Mochizuki et al., 2004), and it exerted their antioxidant and cardiovascular diseases-preventing effect in the SMCs (Yoshizumi et al., 2002). Thus, rutin shows biological effects as quercetin aglycone or quercetin conjugates, when it is metabolized in organ as intestine and liver.

R. Lin and his group (1992) showed that Tartary buckwheat, but not common buckwheat, lowers blood sugars in patients suffering from diabetes mellitus and that Tatary buckwheat flour also lowers serum lipid in patients suffering from hyperlipidemia (Lin et al., 1992). However, the exact mechanisms responsible for the observed beneficial effects for diabetes mellitus and hyperlipidemia remain uncertain.

α-Glucosidase is a major enzyme responsible for the gastrointestinal digestion of saccharides into glucose. α-Glucosidase inhibitor is used as a drug curing diabetes mellitus. Although many factors are involved in preventing diabetes mellitus, α-glucosidase inhibitors in foods, if any, might inhibit the intestinal absorption of glucose, so maybe leading to the prevention of diabetes mellitus.

In this connection, increasing attention in polyphenols present in red wine and various plant foods is paid for beneficial effects on human health (Renaud and De Lorgeril, 1992). It is well known that buckwheat, especially Tartary buckwheat, contains a high level of polyphenols such as rutin and quercetin. It is hoped that polyphenols in common and Tartary buckwheat may have profoundly-beneficial effects on human health.

We have undertaken to identify α-glucosidase inhibitory activity in Tartary buckwheat given clarifying a factor responsible for the report by Lin's group showing that the intake of Tartary buckwheat lowered blood sugar of patients suffering diabetes mellitus (Ikeda et al., 2017).

Our finding showed that quercetin exhibited strong inhibitory activity against α-glucosidase. On the other hand, no inhibitory activity against this enzyme was found with rutin. α-Glucosidase is a major enzyme responsible for the gastrointestinal digestion of saccharides into glucose. α-Glucosidase inhibitor is used as a drug curing diabetes mellitus. Although many factors are involved in preventing diabetes mellitus, α-glucosidase inhibitors in foods, if any, might inhibit the intestinal absorption of glucose, which maybe lead to the prevention of diabetes mellitus. Our study suggests that quercetin may be an important factor responsible for the results reported by Lin's group showing that the intake of Tartary buckwheat lowered blood sugar of patients suffering diabetes mellitus. Further research should be performed for this interesting subject.

2-8 Mechanical characteristics of buckwheat products

Evidence has been accumulated that to enjoy food with high palatability may promote human health and longevity. In view of such evidence, increasing attention is being paid to these basic theories associated with the palatability of foods, from the perspective of their cooking and processing characteristics. However, there are still many unanswered questions on the palatability of buckwheat foods. Mechanical characteristics of buckwheat foods may be an important quality attribute affecting their palatability and acceptability (Ikeda, 2002). Hence, we have been trying to elucidate mechanical characteristics and the theory involved.

2-8-1 Molecular cookery science

"Molecular cookery science" has been proposed by K. Ikeda (1997). The new science will clarify food's palatability from a molecular basis. Textural characteristics, which are one of the mechanical characteristics of foods, are an important quality attribute for aspects of consumer acceptance and preference for foods. The science will be taken by our series of study (Ikeda et al., 1997) showed that endogenous protein and starch are responsible for textural characteristics of common buckwheat products. Furthermore, we showed to relationships of polyacrylamide gel electrophoretic-protein components to the mechanical characteristics of buckwheat dough using with many common buckwheat samples (Asami et al., 2008). The molecular cookery science will be taken over by scientists such as Yuya Asami and Mika Mochizuki.

A possibility showing that Tartary buckwheat may exhibit some beneficial effects on human health has been suggested (see 2-7; Lin et al., 1992). In Japan, various products, including noodles, made from Tartary buckwheat currently become popular. We tried to analyze the effects of rutin on the textural characteristics of Tartary buckwheat dough (Asami et al., 2007). As rutin was incorporated into Tartary buckwheat dough, the hardness of the Tartary buckwheat dough was enhanced and the cohesiveness of the Tartary buckwheat dough was concomitantly decreased. This finding suggests that rutin may be an important factor affecting the textural characteristics of Tartary buckwheat dough.

2-8-2 Scientific analysis of traditional preparation conditions of buckwheat noodles

There are various traditional proverbial sayings about the palatability and acceptability of buckwheat noodles. In such proverbial phrases, buckwheat noodles prepared with all parts of the following four conditions are believed to be more palatable and acceptable; firstly, noodles made from just-harvested and dried buckwheat seed; secondly, noodles made from just-ground buckwheat flour; thirdly, just-prepared buckwheat noodles; and lastly, just-boiled buckwheat noodles. In Japan it has been believed that buckwheat noodles made with all of the above four conditions may be the most palatable. In view of clarifying the above traditional proverbial saying, we analyzed mechanical changes in buckwheat noodles prepared under various conditions.

We tried to analyze the impact of storage to mechanical characteristics of noodles prepared from buckwheat grain stored under various conditions (Asami and Ikeda, 2005). Our chemical analysis showed a decrease in the breaking stress and energy of the resultant noodles prepared from stored buckwheat grain. These findings suggested that the temperature, relative humidity and the length of the storage period in the storage of buckwheat grain are important factors affecting the mechanical characteristics of its resultant noodles.

Another study (Asami et al., 2022) was performed to analyze the mechanical effects of leaving buckwheat noodles after their freshly making with or without subsequent cooking. After their freshly making and subsequent cooking, a remarkable reduction with time in breaking characteristics was found. The observed decrease in breaking stress and energy showed that the buckwheat noodles might be softened with the leaving time. On the other hand, our analysis showed that no brittleness was found in buckwheat noodles from the beginning until the early leaving time (within 1 min), whereas brittleness, which is unpalatable factor, appeared after leaving time of 2 min after subsequent cooking.

Our serious study on the mechanical characteristics of buckwheat products shows some scientific basis involved in traditional preparation conditions of buckwheat noodles.

2-9 Dietary buckwheat enhances sirtuin without calorie restriction.

Some recent reports show a relationship between buckwheat intake and sirtuin (Pande et al., 2020; 2022). Dietary buckwheat is reported to enhance sirtuin without calorie restriction (Pande et al., 2020). Although these reports are very interesting, further studies are needed. In Japan, the authors often asked opinions suggesting that people, handing at a milling companies or buckwheat farm, often live long lives. For the authors, there was no way to answer when there was no academic question. But, the reports by Pande et al. (2020; 2022) are very interesting, and we hope that the exact mechanism involved will be clarified in the future.

On the other hand, a recent report show that buckwheat and starch improve age-related dementia (Katayama et al., 2022). Clarification of the details of this mechanism will be expected.

There are many unanswered questions on buckwheat research. We hope these unanswered questions will be clarified fully for human health in the future.

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IZVLEČEK

Pregled o ajdi: zgodovinski podatki o uporabi ajde v Kitajski in Japonski ter prispevek ajde k prehrani ljudi.

Prispevek obravnava dve tematiki. Prva je zgodovinski pregled pridelovanja ajde v Kitajski in Japonski. Drugi del je razprava o pomenu ajde v prehrani ljudi.