

(様式1)

公益社団法人日本栄養・食糧学会 研究業績

<学 会 賞>

1. 候補者

研究題目:(和)	農産食品素材の腸内環境改善効果に関する基礎的研究		
(英)	Studies on the improvement of intestinal environment and functions with agricultural food products		
氏 名:(和)	福島 道広		
(英)	Michihiro Fukushima		
所属機関:(和)	帯広畜産大学畜産学部生命・食料科学研究部門 教授 副学長兼任		
(英)	Department of Life and Food Sciences, Obihiro University of Agriculture and Veterinary Medicine, Professor, Vice President		
学 位:	博士(農学)	最終学歴:	昭和 60 年 3 月帯広畜産大学大学院畜産研究科畜産環境学専攻修士課程修了
専門分野	○①栄養生理学、○②栄養生化学、③分子栄養学、④公衆栄養学、⑤臨床・病態栄養学、⑥食生態学、⑦調理科学、⑧食品化学・食品分析学、○⑨食品機能学、⑩食品工学、⑪食品加工・流通・貯蔵学、⑫食品衛生・安全学、⑬生理学、⑭生化学、⑮分子生物学、⑯臨床医学(内科系)、⑰臨床医学(外科系) ⑱その他		
履 歴	平成元年 10 月 帯広畜産大学畜産学部助手 平成 11 年 4 月 帯広畜産大学畜産学部助教授 平成 13 年 10 月～平成 14 年 7 月 Health Sciences and Nutrition, Commonwealth Scientific and Industrial Research Organisation (CSIRO) (オーストラリア) 文部科学省在外研究員 平成 19 年 2 月 帯広畜産大学畜産学部教授 平成 28 年 4 月～ 帯広畜産大学副理事兼任 平成 30 年 4 月～ 帯広畜産大学副学長兼任 現在に至る		
会員番号:		入会年度:	

## 2. 研究業績要旨(1,000字以内)

腸内環境はヒトの健康に大きな役割を持っており、腸内細菌叢や腸内発酵特性を明らかにすることは重要である。申請者は、プロバイオティクスおよびプレバイオティクスに関わる研究を長年続けてきた。まず、乳酸菌や酵母などの複合菌調整物を作成して健康機能性を検討した。その結果、ビフィズス菌を増やすなど腸内微生物叢の改善に伴うコレステロール代謝の改善を明らかにした。また、*Lactobacillus acidophilus*でも腸管でのミセル形成阻害などによる血清コレステロール低下作用を初めて示した。これらの研究は、その後盛んとなったプロバイオティクス研究の先駆け的研究となり、新たな食品開発への展開や家畜動物等の健康に寄与する生菌剤としても利用されるに至っている。その後申請者は、北海道十勝産の農産物を中心に数多くの農産食品素材の健康機能性を探索した。それらの一つであるマッシュルームから調製した食物繊維では、血清コレステロール濃度低下作用を見出し、その原因は、腸内発酵促進による短鎖脂肪酸の増加によることを見出した。また、小豆やインゲン豆、ジャガイモに豊富に含まれる難消化性澱粉でも同様に、盲腸内で短鎖脂肪酸が増加し、コレステロールや脂質代謝に好影響をもたらすことを初めて明らかにすることに成功した。このように多くの農産物が、腸内環境を整え、脂質代謝改善作用などをもたらすことを系統的に明らかにしたことで、特に北海道産農産物の新たな製品化や食育への理論づけに大きく貢献することができた。これらの腸内環境に関する *in vivo* での検討に加え、より迅速に腸内発酵状態を調べることができる *in vitro* による腸内発酵実験モデルを構築した。その結果、いくつかの食品素材の影響や腸内発酵の経時的変化を短期間で調べることができるようになり、この *in vitro* 系が *in vivo* に近い条件であることを示唆する腸内細菌叢および短鎖脂肪酸などの結果も得られていることから、腸内環境研究の進展に寄与する新たな実験系を確立することに成功した。

申請者の研究は、腸内環境改善に関する基礎的研究であるが、ひいては生活習慣病の予防、改善を通して日本人やアジアの人々の健康長寿の維持・増進に大きく貢献するものである。

### 3. 報文等リスト

#### (1) この研究に直接関連するもの(10 編以内)

- 1) Pelpolage, SW., Goto, Y., Nagata, R., Fukuma, N., Furuta, T., Mizu, M., Han, KH., Fukushima, M. Colonic fermentation of water soluble fiber fraction extracted from sugarcane (*Saccharum officinarum* L.) bagasse in murine models. *Food Chemistry*, **292**: 336-345 (2019)
- 2) Kilua, A., Nomata, R., Nagata, R., Fukuma, N., Shimada, K., Han, KH., Fukushima, M. Purple sweet potato polyphenols differentially influence the microbial composition depending on the fermentability of dietary fiber in a mixed culture of swine fecal bacteria. *Nutrients*, **11**: 1495 (2019)
- 3) Han, KH., Azuma, S., Fukushima, M. In vitro fermentation of spent turmeric powder with a mixed culture of pig faecal bacteria. *Food & Function*, **5**: 2446-2452 DOI: 10.1039/c4fo00142g (2014)
- 4) Han, KH., Hayashi, N., Hashimoto, N., Shimada, K., Sekikawa, M., Noda, T., Fukushima, M. Feeding potato flakes affects cecal short-chain fatty acids, microflora and fecal bile acids in rats. *Annals of Nutrition & Metabolism*, **52**: 1-7 (2008)
- 5) Liyanage, R., Hashimoto, N., Han, KH., Kajiura, T., Watanabe, S., Shimada, K., Sekikawa, M., Ohba, K., Fukushima, M. Some bovine proteins behave as dietary fibres and reduce serum lipids in rats. *British Journal of Nutrition*, **97**: 898-905 (2007)
- 6) Han, KH., Iijuka, M., Shimada, K., Sekikawa, M., Kuramochi, K., Ohba, K., Liyanage, R., Chiji, H., Fukushima, M. Adzuki resistant starch lowered serum cholesterol and hepatic 3-hydroxy-3-methylglutaryl-CoA mRNA levels and increased hepatic LDL-receptor and cholesterol 7 $\alpha$ -hydroxylase mRNA levels in rats fed a cholesterol diet. *British Journal of Nutrition*, **94**: 902-908 (2005)
- 7) Fukushima, M., Ohashi, T., Fujiwara, Y., Sonoyama, K., Nakano, M., Cholesterol-lowering effects of maitake (*Grifola frondosa*) fiber, shiitake (*Lentinus edodes*) fiber, enokitake (*Flammulina vlitipes*) fiber in rats. *Experimental Biology and Medicine*, **226**: 758-765 (2001)
- 8) Fukushima, M., Nakano, M., Morii, Y., Fujiwara, Y., Sonoyama, K. Hepatic LDL receptor mRNA in rats is increased by dietary mushroom (*Agaricus bisporus*) fiber and sugar beet fiber. *Journal of Nutrition*, **130**: 2151-2156 (2000)
- 9) Fukushima, M., Nakano, M. Effects of a mixture of organisms, *Lactobacillus acidophilus* or *Streptococcus faecalis* on cholesterol metabolism in rats fed on a fat- and cholesterol-enriched diet. *British Journal of Nutrition*, **76**: 857-867 (1996)
- 10) Fukushima, M., Nakano, M. The effect of a probiotic on faecal and liver lipid classes in rats. *British Journal of Nutrition*, **73**: 701-710 (1995)

#### (2) その他の論文(編数制限なし)(太字はこの研究に直接関連するもの、\*は JNSV に掲載) 学術論文

- 1) Nagata, R., Kamibayashi, R., Bochimoto, H., Fukuma, N., Shimada, K., Tachibe, M., Takaishi, Y., Han, KH., M., Fukushima, M. Chemical modification of cornstarch by hydroxypropylation enhances cecal fermentation-mediated lipid metabolism in rats. *Starch-Starke*, DOI: 10.1002/star.201900050 (2019)
- 2) Yamada, T., Hino, S., Iijima, H., Genda, T., Aoki, R., Nagata, R., Han, KH., Hirota, M., Kinashi,

Y., Oguchi, H., Suda, W., Furusawa, T., Fujimura, Y., Kunisawa, J., Hattori, M., Fukushima, M., Morita, T., Hase, K. Mucin O-glycans facilitate symbiosynthesis to maintain gut immune homeostasis. *EBioMedicine*, <https://doi.org/10.1016/j.ebiom.2019.09.008> (2019)

- 3) Pelpolage, SW., Han, KH., Koase, H., Hamamoto, T., Hoshizawa, M., Fukushima, M. Influence of enzyme-resistant fraction of sorghum (*Sorghum bicolor* L.) flour on gut microflora composition, short chain fatty acid production and toxic substance metabolism. *Journal of Food and Nutrition Research*, **58**: 135-145 (2019)
- 4) Kitano-Okada, T., Nagata, R., Han, KH., Mikami, N., Nishihira, J., Sasaki, K., Ohba, K., Fukushima, M. Safety and efficacy of adzuki bean extract in subjects with moderate to high LDL-C: a randomized trial. *Bioscience, Biotechnology, and Biochemistry*, **83**: 933-941 (2019)
- 5) Yamamoto, M., Horie, M., Fukushima, M., Toyotome, T. Culture-based analysis of fungi in leaves after the primary and secondary fermentation processes during Ishizuchi-kurocha production and lactate assimilation of *P. kudriavzevii*. *International Journal of Food Microbiology*, **306**:108263 (2019)
- 6) Bochimoto, H., Kondoh, D., Nagata, R., Ishihara, T., Tomiyasu, J., Han, KH., Shimada, K., Sasaki, M., Kitamura, N., Fukushima, M. Ultrastructural changes in colonic epithelial cells in a rat model of inflammatory bowel disease. *Microscopy Research and Technique*, **82**:1339-1344 (2019)
- 7) Kilua, A., Han, KH., Shimada, K., Hashimoto, N., Fukushima, M. The effect of potato polyphenols in combination with cellulose or inulin in a mixed culture of swine fecal bacteria. *International Journal of Food and Nutritional Science*, **5**: 7-15 (2018)
- 8) 平田浩, 本間智子, 永田龍次, 韓圭鎬, 島田謙一郎, 日高智, 岡田秀紀, 福島道広. 植物エキス発酵液の製造副産物が腸内環境に与える影響. *ルミナコイド研究*, **22** : 11-20 (2018)
- 9) Nagata, R., Echizen, M., Yamaguchi, Y., Han, KH., Shimada, K., Ohba, K., Kitano-Okada, T., Nagura, T., Uchino, H., Fukushima, M. Effect of a combination of inulin and polyphenol-containing adzuki bean extract on intestinal fermentation *in vitro* and *in vivo*. *Bioscience, Biotechnology, and Biochemistry*, **82**: 489-496 (2018)
- 10) \*永田龍次, 佐川愛, 韓圭鎬, 島田謙一郎, 加藤清明, 佐藤毅, 福島道広. 炊飯処理後の各種米粉投与がラットの腸内発酵に与える影響. *日本栄養・食糧学会誌*, **70**:61-67 (2017)
- 11) Han, KH., Yamamoto, A., Shimada, K., Hashimoto, N., Nagura, T., Fukushima, M. Dietary fat content modulates the hypolipidemic effect of dietary inulin in rats. *Molecular Nutrition & Food Research*, **68**: 1600635 (2017) DOI: 10.1002/mnfr.201600635
- 12) Hashimoto, N., Han, KH., Fukushima, M. Intraduodenal infusion of cyanidin-3-glucoside transiently promotes triglyceride excretion into bile in rats. *Nutrition Research*, **38**: 34-42 (2017)
- 13) Kawakami, S., Han, KH., Araki, T., Ohba, K., Wakabayashi, T., Shimada, K., Fukushima, M. Potato powders prepared by successive cooking-process depending on resistant starch content affect the intestinal fermentation in rats. *Bioscience, Biotechnology, and Biochemistry*, **81**: 359-364 (2017)
- 14) 葛西大介, 梅沢晃, 輿水美奈, 佐々木恵子, 大庭潔, 菊地裕人, 内野浩克, 赤部紀夫, 韓圭鎬, 島田謙一郎, 福島道広. イヌリン・ホエイ混合物が便秘傾向を有する健常成人男女の排便状態および腸内細菌叢に及ぼす影響. *ルミナコイド研究*, **20**:95-103 (2016)

- 15) 葛西大介, 興水美奈, 大庭潔, 長谷川秀樹, 名倉泰三, 山内宏昭, 韓圭鎬, 島田謙一郎, 福島道広. ベタイン添加食パンの製パン性の改善. *日本食品科学工学会誌*, **63**:405-414(2016)
- 16) Kawakami, S., Araki, T., Ohba, K., Sasaki, K., Kamada, T., Shimada, K., Han, KH., Fukushima, M. Comparison of the effect of two types of whole mushroom (*Agaricus bisporus*) powders on intestinal fermentation in rats. *Bioscience, Biotechnology, and Biochemistry*, **80**: 2001-2006 (2016)
- 17) Han, KH., Lee, CH., Kinoshita, M., Oh, CH., Shimada, K., Fukushima, M. Spent turmeric reduces fat mass in rats fed a high-fat diet. *Food & Function*, **7**: 1814-1824 (2016)
- 18) Han, KH., Hashimoto, N., Fukushima, M. Relationships among alcoholic liver disease, antioxidants, and antioxidant enzymes. *World Journal of Gastroenterology*, **22**: 37-49 (2016)
- 19) Lee, S., Han, KH., Nakamura, Y., Kawakami, S., Shimada, K., Hayakawa, T., Onoue, H., Fukushima, M. Dietary L-cysteine inhibits D-galactosamine-induced acute liver injury in rats. *Food Science and Biotechnology*, **24**: 1151-1157 (2015)
- 20) Han, KH., Kitano-Okada, T., Seo, JM., Kim, SJ., Sasaki, K., Shimada, K., Fukushima, M. Characterisation of anthocyanins and proanthocyanidins of adzuki bean extracts and their antioxidant activity. *Journal of Functional Foods*, **14**: 692-701 (2015)
- 21) Han, KH., Senba, K., Shimada, K., Hayakawa, T., Morimatsu, F., Takahata, Y., Yoon, TJ., Fukushima, M. Porcine splenic hydrolysate has antioxidant activity *in vivo* and *in vitro*. *Korean Journal for Food Science of Animal Resources*, **34**: 325-332 (2014)
- 22) Lee, CH., Kim, AY., Pyum, CW., Fukushima, M., Han, KH. Turmeric (*Curcuma longa*) Whole Powder Reduces the Accumulation of Visceral Fat Mass But Also Increases Hepatic Oxidative Stress in Rats Fed a High-Fat Diet. *Food Science and Biotechnology*, **23**: 261-267 (2014)
- 23)\*Han, KH., Kobayashi, Y., Nakamura, Y., Shimada, K., Aritsuka, T., Ohba, K., Morita, T., Fukushima, M. Comparison of the effects of longer chain inulins with different degrees of polymerization on colonic fermentation in a mixed culture of swine fecal bacteria. *Journal of Nutritional Science and Vitaminology*, **60**: 206-212 (2014)
- 24) Nishimura, N., Tanabe, H., Adachi, M., Yamamoto, T., Fukushima, M. Colonic hydrogen generated from fructan diffuses into the abdominal cavity and reduce adipose mRNA abundance of cytokines in rats. *Journal of Nutrition*, **143**: 1943-1949 (2013)
- 25) Han, KH., Kim, SJ., Shimada, K., Hashimoto, N., Yamauchi, H., Fukushima, M. Purple potato flake reduces serum lipid profile in rats fed a cholesterol-rich diet. *Journal of Functional Foods*, **5**: 974-980 (2013)
- 26) Han, KH., Tsuchihira, H., Nakamura, Y., Shimada, K., Ohba, K., Aritsuka, T., Uchino, H., Kikuchi, H., Fukushima, M. Inulin-type fructans with different degrees of polymerization improve lipid metabolism but not glucose metabolism in rats fed a high-fat diet under energy restriction. *Digestive Diseases and Sciences*, **58**: 2177-2186 (2013)
- 27) Morita, T., Hino, S., Ito, A., Han, KH., Shimada, K., Fukushima, M. Slower fermentation rate of potato starch relative to high-amylose cornstarch contributes to the higher proportion of cecal butyrate in rats. *Bioscience of Microbiota, Food and Health*, **32**: 149-156 (2013)
- 28) Lee, S., Han, KH., Nakamura, Y., Kawakami, S., Shimada, K., Hayakawa, T., Onoue, H., Fukushima, M. Dietary L-cysteine improves antioxidant potential and lipid metabolism in rats fed a normal diet. *Bioscience, Biotechnology, and Biochemistry*, **77**: 1430-1434 (2013)

- 29)** Hashimoto, N., Shinomiya, N., Saito, K., Noda, T., Han, KH., Fukushima, M. Effect of potato ethanol residue on rat plasma cholesterol levels. *Bioscience, Biotechnology, and Biochemistry*, **77**: 850-852 (2013)
- 30)** Jayawardana, BC., Yanagihara, M., Han, KH., Ishii, H., Fukushima, M., Sekikawa, M., Shimada, K. Effects of anthocyanin-rich colored potato flakes on lipid oxidation, instrumental color evaluation and sensory characteristics in cooked pork sausages. *Food Science and Technology Research*, **18**: 455-460 (2012)
- 31)** Kitano-Okada, T., Ito, A., Koide, A., Nakamura, Y., Han, KH., Shimada, K., Ohba, K., Sibayama, S., Fukushima, M. Anti-obesity role of adzuki bean extract containing polyphenols: in vivo and in vitro effects. *Journal of the Science of Food Agriculture*, **92**: 2644-2651 (2012)
- 32)** Han, KH., Sekikawa, M., Shimada, K., Lee, CH., Hashimoto, N., Fukushima, M. Japanese butterbur (*Petasites japonicus*) leaves increase hepatic oxidative stress in male rats. *Bioscience, Biotechnology, and Biochemistry*, **76**: 2026-2031 (2012)
- 33)\*** Kawakami, S., Han, KH., Nakamura, Y., Shimada, K., Kitano, T., Aritsuka, T., Nagura T., Ohba, K., Nakamura, K., Fukushima, M. Effects of dietary supplementation with betaine on a nonalcoholic steatohepatitis (NASH) mouse model. *Journal of Nutritional Science and Vitaminology*, **58**: 371-375 (2012)
- 34)** Jayawardana, BC., Hirano T., Han, KH., Ishii, H., Okada, T., Shibayama, S., Fukushima, M., Sekikawa, M., Shimada, K. Utilization of adzuki bean extract as a natural antioxidant in cured and uncured cooked pork sausages. *Meat Science*, **89**: 150-153 (2011)
- 35)** Hashimoto, N., Nakamura, Y., Noda, T., Han, KH., Fukushima, M. Effects of feeding potato pulp on cholesterol metabolism and its association with cecal conditions in rats. *Plant Foods for Human Nutrition*, **66**: 401-407 (2011)
- 36)** Okada, T., Kawakami, S., Nakamura, Y., Han, KH., Ohba, K., Aritsuka, T., Uchino, H., Shimada, K., Sekikawa, M., Ishii, H., Fukushima, M. Amelioration of D-galactosamine-induced acute liver injury in rats by dietary supplementation with betaine derived from sugar beet molasses. *Bioscience, Biotechnology, and Biochemistry*, **75**: 1335-1341 (2011)
- 37)\*** Nishimura, N., Tanabe, H., Yamamoto, T., Fukushima, M. Raw Chinese yam (*Dioscorea opposita*) promotes cecal fermentation and reduces plasma non-HDL cholesterol concentration in rats. *Journal of Nutritional Science and Vitaminology*, **57**: 340-347 (2011)
- 38)** Mineo, H., Morikawa, N., Ohmi, S., Ishida, K., Machida, A., Kanazawa, T., Chiji, H., Fukushima, M., Noda, T. Ingestion of potato starch containing esterified phosphorus increases alkaline phosphatase activity in the small intestine in rats. *Nutrition Research*, **30**: 341-347 (2010)
- 39)** Liyanage, R., Minamino, S., Nakamura, Y., Shimada, K., Sekikawa, M., Sasaki, K., Ohba, K., Jayawardana, BC., Shibayama, S., Fukushima, M. Preparation method modulates hypocholesterolaemic responses of potato peptides. *Journal of Functional Foods*, **2**: 118-125 (2010)
- 40)** 岡田朋子, 山影はるか, 川上秋桜, 中村有美, 韓圭鎬, 島田謙一郎, 関川三男, 紙谷年昭, 戸田登志也, 柴山進一, 福島道広, ラットの脂質代謝および腸内細菌叢に及ぼすポテトペプチドおよび金時豆同時摂取の影響. *日本食物繊維学会誌*, **14**: 45-54 (2010)
- 41)** Hagio, M., Matsumoto, M., Fukushima, M., Hara, H., Ishizuka, S. Improved analysis of bile acids in tissues and intestinal contents of rats using LC/ESI-MS. *Journal of Lipid Research*, **50**: 173-180 (2009)

- 42)** Liyanage, R., Nakamura, Y., Shimada, K., Sekikawa, M., Jayawardana, BC., Han, KH., Okada, T., Ohba, K., Takahata, Y., Morimatsu, F., Fukushima, M. Porcine artery elastin preparation reduces serum cholesterol level in rats. *Journal of Functional Foods*, **1**: 405-409 (2009)
- 43)** Liyanage, R., Han, KH., Shimada, K., Sekikawa, M., Tokuji, Y., Ohba, K., Sasaki, K., Jayawardana, BC., Shimizu, T., Fukushima, M. Potato and soy peptides alter caecal and faecal lipids in rats fed cholesterol. *European Journal of Lipid Science and Technology*, **111**: 884-892 (2009)
- 44)** Mineo, H., Ohmi, S., Ishida, K., Morikawa, N., Machida, A., Kanazawa, T., Chiji, H., Fukushima, M., Noda, T. Ingestion of potato starch containing high levels of esterified phosphorus reduces calcium and magnesium absorption and their femoral retention in rats. *Nutrition Research*, **29**: 648-655 (2009)
- 45) Jayawardana, BC., Shimada, K., Liyanage, R., Fukushima, M., Sekikawa, M. removing of central nervous tissues from dressed carcasses: Washing with a low concentration of lactic acid in spraying cabinet. *Food Control*, **20**: 386-390 (2009)
- 46)** Nakamura, Y., Yabe, K., Shimada, K., Sasaki, K., Han, KH., Okada, T., Sekikawa, M., Ohba, K., Ito, N., Horiuchi, K., Kawakami, S., Fukushima, M. Effects of fermented bean paste on serum lipids in rats fed a cholesterol-free diet. *Bioscience, Biotechnology, and Biochemistry*, **73**: 2506-2512 (2009)
- 47)** Nakamura, Y., Kanazawa, M., Liyanage, R., Iijima, S., Han, KH., Shimada, K., Sekikawa, M., Yamauchi, A., Hashimoto, N., Ohba, K., Fukushima, M. Effect of white wheat bread containing sugar beet fiber on serum lipids and hepatic mRNA in rats fed a cholesterol-free diet. *Bioscience, Biotechnology, and Biochemistry*, **73**: 1280-1285 (2009)
- 48) Jayawardana, BC., Shimada, K., Fukushima, M., Sekikawa, M. Study on presence/absence of central nervous tissues as BSE specified risk material in processed and raw meat products in Japan. *Food Control*, **20**: 187-190 (2009)
- 49)** Ohba, K., Han, KH., Liyanage, R., Nirei, M., Hashimoto, N., Shimada, K., Sekikawa, M., Sasaki, K., Lee, CH., Fukushima, M. Hepatoprotective effects of potato peptide against D-galactosamine-induced liver injury in rats. *Food Science and Biotechnology*, **17**: 1178-1184 (2008)
- 50)** Liyanage, R., Han, KH., Watanabe, S., Shimada, K., Sekikawa, M., Ohba, K., Tokuji, Y., Ohnishi, M., Shibayama, S., Nakamori, T., Fukushima, M. Potato and soy peptide diets modulate lipid metabolism in rats. *Bioscience, Biotechnology, and Biochemistry*, **72**: 943-950 (2008)
- 51)** Kanazawa, T., Atsumi, M., Mineo, H., Fukushima, M., Nishimura, N., Noda, T., Chiji, H. Ingestion of gelatinized potato starch containing a high level of phosphorus decreases serum and liver lipids in rats. *Journal of Oleo Science*, **57**: 335-343 (2008)
- 52)** Mieno, H., Kanazawa, T., Morokawa, N., Ishida, K., Ohmi, S., Machida, A., Noda, T., Fukushima, M., Chiji, H. Feeding of potato starch increases maltase and sucrose activity only in duodenal segment of the small intestine in rats. *Journal of Applied Glycoscience*, **55**: 203-209 (2008)
- 53)** \*Kuwabara, T., Han, KH., Hashimoto, N., Yamauchi, H., Shimada, K., Sekikawa, M., Fukushima, M. Tartary buckwheat sprout powder lowers plasma cholesterol level in rats. *Journal of Nutritional Science and Vitaminology*, **53**: 501-507 (2007)
- 54)** Han, KH., Matsumoto, A., Shimada, K., Sekikawa, M., Fukushima, M. Effects of anthocyanin-rich purple potato flakes on antioxidant status in F344 rats fed a cholesterol-rich

diet. *British Journal of Nutrition*, **98**: 914-921 (2007)

- 55)** Han, KH., Ohba, K., Lee, CH., Shimada, K., Sekikawa, M., Fukushima, M. Lipid metabolism in rats fed acetaminophen with coadministration of adzuki bean extract. *Food Science and Biotechnology*, **16**: 584-589 (2007)
- 56)** Ohba, K., Watanabe, S., Han, KH., Hashimoto, N., Noda, T., Shimada, K., Tanaka, H., Sekikawa, M., Fukushima, M. Effect of colored potato flakes against acetaminophen-induced liver damage in rats. *Food Science and Biotechnology*, **16**: 463-469 (2007)
- 57)** Han, KH., Shimada, K., Sekikawa, M., Fukushima, M. Anthocyanin-rich red potato flakes affect serum lipid peroxidation and hepatic SOD mRNA level in rats. *Bioscience, Biotechnology, and Biochemistry*, **71**: 1356-1359 (2007)
- 58)** Yamauchi, H., Ito, Nishio, Tabiki, T., Kim, SJ., Hashimoto, N., Noda, T., Takigawa, S., Matsuura-Endo, C., Takata, K., Ohta, K., Fukushima, M., Miura, H., *Ism Z.* Effects of high-molecular-weight glutenin subunits on the texture of yellow alkaline noodles using near-isogenic lines. *Food Science and Technology Research*, **13**: 227-234 (2007)
- 59)** Ito, M., Kim, SJ., Sarker, ZI., Hashimoto, N., Noda, T., Takigawa, S., Matsuura-Endo, C., Horibata, T., Nakaura, Y., Inouchi, N., Fukushima, M., Yamauchi, H. Staling and texture of bread prepared from new Japanese bread wheat varieties with slightly low-amylose starch. *Food Science and Technology Research*, **13**: 121-128 (2007)
- 60)** Mineo, H., Ishida, K., Morikawa, N., Ohmi, S., Machida, A., Noda, T., Fukushima, M., Chiji, H. Ingestion of potato starch decrease chymotrypsin but does not affect trypsin, amylase, or lipase activity in the pancreas in rats. *Nutrition Research*, **27**: 113-118 (2007)
- 61)** Han, KH., Sekikawa, M., Shimada, K., Hashimoto, M., Hashimoto, N., Noda, T., Tanaka, H., Fukushima, M. Anthocyanin-rich purple potato flake extract has antioxidant capacity and improves antioxidant potential in rats. *British Journal of Nutrition*, **96**: 1125-1133 (2006)
- 62)\*** Hashimoto, N., Ito, Y., Han, KH., Shimada, K., Sekikawa, M., Topping, DL., Bird, AR., Noda, T., Chiji, H., Fukushima, M. Potato pulps lowered the serum cholesterol and triglyceride levels in rats. *Journal of Nutritional Science and Vitaminology*, **52**: 445-450 (2006)
- 63)** Han, KH., Hashimoto, N., Hashimoto, M., Noda, T., Shimada, K., Lee, CH., Sekikawa, M., Fukushima, M. Red potato extract protects against D-galactosamine-induced liver Injury in rats. *Bioscience, Biotechnology, and Biochemistry*, **70**: 2285-2288 (2006)
- 64)** Han, KH., Hashimoto, N., Shimada, K., Sekikawa, M., Noda, T., Yamauchi, H., Hashimoto, M., Chiji, H., Topping, DL., Fukushima, M. Hepatoprotective effects of purple potato against D-galactosamine-induced liver injury in rats. *Bioscience, Biotechnology, and Biochemistry*, **70**: 1432-1437 (2006)
- 65)** Tanaka, Y., Miura, H., Fukushima, M., Ito, M., Nshio, Z., Kim, SJ., Hashimoto, N., Noda, T., Takigawa, S., Matsuura-Endo, C., Yamauchi, H. Physical properties of yellow alkaline noodles from near-isogenic wheat lines with different Wx protein deficiency. *Starch/Starke*, **58**: 186-195 (2006)
- 66)** Noda, T., Fujikami, S., Miura, H., Fukushima, M., Takigawa, S., Matsuura-Endo, C., Kim, SJ., Hashimoto, N., Yamauchi, H. Effect of potato starch characteristics on the textural properties of Korean-style cold noodles made from wheat flour and potato starch blends. *Food Science and Technology Research*, **12**: 278-283 (2006)
- 67)** Han, KH., Jeon, YJ., Athukorala, Y., Choi, KD., Kim, CJ., Cho, JK., Sekikawa, M., Fukushima,



- M., Lee, CH. A water extract of *Artemisia capillaris* prevents 2,2'-azobis dihydrochloride-induced liver damage in rats. *Journal of Medicinal Food*, **9**: 342-347 (2006)
- 68) Nam, HY., Min, SG., Shin, HC., Kim, HY., Fukushima, M., Han, KH., Park, WJ., Choi, KD., Lee, CH. The protective effects of isoflavone extracted from soybean paste in free radical initiator treated rats. *Food Science and Biotechnology*, **14**: 586-592 (2005)
- 69) Ohba, K., Nirei, M., Watanabe, S., Han, KH., Hashimoto, N., Shimada, K., Sekikawa, M., Chiji, H., Fukushima, M. Effects of adzuki bean extract on hepatic anti-oxidant enzyme mRNAs In D-galactosamine-treated rats. *Bioscience, Biotechnology, and Biochemistry*, **69**: 1988-1991 (2005)
- 70)\*Fukushima, M., Han, KH., Taneichi, Y., Iijima, S., Shimada, K., Saitoh, K., Oda, Y., Chiji, H., Sekikawa, M. *Amylomyces rouxii* strain CBS 438.75 affects cholesterol metabolism in cholesterol-fed rats. *Journal of Nutritional Science and Vitaminology*, **51**: 453-459 (2005)
- 71) Ohba, K., Fukushima, M., Han, KH., Tamura, A., Watanabe, S., Hashimoto, N., Shimada, K., Chiji, H., Sekikawa, M. Fat- and cholesterol-enriched diet feeding affects gene expression related to cholesterol metabolism in rats. *Journal of Oleo Science*, **54**: 453-459 (2005)
- 72)\*Han, KH., Fukushima, M., Ohba, K., Shimada, K., Sekikawa, M., Chiji, H., Lee, CH., Nakano, M. Hepatoprotective effects of the water extract of adzuki bean hulls on acetaminophen-induced liver damage in rats. *Journal of Nutritional Science and Vitaminology*, **50**: 380-383 (2004)
- 73) Han, KH., Ohashi, T., Kojima, M., Fukushima, M. Effect of dietary fiber of some beans on serum cholesterol concentration in rats. *Food Science and Biotechnology*, **13**: 147-150 (2004)
- 74) Shimada, K., Sakuma, Y., Wakamatsu, J., Fukushima, M., Sekikawa, M., Kuchida, K., Mikami, M. Species and muscle differences in L-carnitine levels in skeletal muscles based on a new simple assay. *Meat Science*, **68**: 357-362 (2004)
- 75) Han, KH., Sekikawa, M., Shimada, K., Sasaki, K., Ohba, K., Fukushima, M. Resistant starch fraction prepared from kintoki bean affects gene expression of genes associated with cholesterol metabolism in rats. *Experimental Biology and Medicine*, **229**: 787-792 (2004)
- 76)\*Tamura, A., Fukushima, M., Shimada, K., Han, KH., Sekikawa, M., Watanabe, S., Nakano, M., Matsumoto, M., Chiji, H. Cholesterol metabolism in rats is affected by protocatechuic acid. *Journal of Nutritional Science and Vitaminology*, **50**: 13-18 (2004)
- 77)\*Han, KH., Fukushima, M., Shimizu, K., Kojima, M., Ohba, K., Tanaka, A., Shimada, K., Sekikawa, M., Nakano, M. Resistant starch of beans reduced serum cholesterol concentration in rats. *Journal of Nutritional Science and Vitaminology*, **49**: 281-287 (2003)
- 78) Topping, DL., Fukushima, M., Bird, AR. Resistant starch as a prebiotic and synbiotic: state of the art. *Proceedings of Nutrition Society*, **62**: 171-176 (2003)
- 79) Han, KH., Fukushima, M., Kato, T., Kojima, M., Ohba, K., Shimada, K., Sekikawa, M., Nakano, M. Enzyme-resistant fractions of beans lowered serum cholesterol and increased sterol excretion and hepatic mRNA levels in rats. *Lipids*, **38**: 919-924 (2003)
- 80) Fukushima, M., Ohashi, T., Kojima, M., Ohba, K., Shimizu, H., Sonoyama, K., Nakano, M. Low density lipoprotein receptor mRNA in rat liver is affected by resistant starch of beans. *Lipids*, **36**: 129-134 (2001)
- 81)\*Fukushima, M., Shimada, K., Ohashi, T., Saitoh, H., Sonoyama, K., Sekikawa, M., Nakano, M. Investigation of gene expressions related to cholesterol metabolism in rats fed diets enriched in

n-6 or n-3 fatty acid with a cholesterol after long-term feeding using quantitative-competitive RT-PCR analysis. *Journal of Nutritional Science and Vitaminology*, **47**: 228-235 (2001)

- 82)** Fukushima, M., Ohhashi, T., Ohno, S., Saitoh, H., Sonoyama, K., Shimada, K., Sekikawa, M., Nakano, M. Effects of diets enriched in n-6 or n-3 fatty acids on cholesterol metabolism in older rats chronically fed a cholesterol-enriched diet. *Lipids*, **36**: 261-266 (2001)
- 83) Sekikawa, M., Yamamoto, M., Fukushima, M., Shimada, K., Ishikawa, T., Mikami, M. Effect of proteasome inhibitor on sarcoplasmic protein of bovine skeletal muscle during storage. *Food Chemistry*, **73**: 17-21 (2001)
- 84) Sekikawa, M., Shimada, K., Fukushima, M., Ishikawa T., Wakamatu, J., Mikami, M. Presence of ubiquitin in bovine post-mortem cardiac muscle. *Food Chemistry*, **69**: 315-318 (2000)
- 85)** Fukushima, M., Doi, S., Ohashi, T., Endo, T., Saitoh, H., Nakano, M. A mixture of organisms affects cholesterol metabolism together with rat cecal flora. *Bioscience, Biotechnology, and Biochemistry*, **63**: 1160-1164 (1999)
- 86)** Endo, T., Nakano, M., Shimizu, S., Fukushima, M., Miyoshi, S. Effects of a probiotic on the lipid metabolism of cocks fed on a cholesterol-enriched diet. *Bioscience, Biotechnology, and Biochemistry*, **63**: 1569-1575 (1999)
- 87)** Fukushima, M., Ohashi, T., Sekikawa, M., Nakano, M. Comparative hypocholesterolemic effects of five animal oils in cholesterol-fed rats. *Bioscience, Biotechnology, and Biochemistry*, **63**: 202-205 (1999)
- 88)** Fukushima, M., Fujii, S., Yoshimura, Y., Endo, T., Nakano, M. Effect of rice bran on intrainestinal fermentation and cholesterol metabolism in cecectomized rats. *Nutrition Research*, **19**: 235-245 (1999)
- 89)** Fukushima, M., Yamada, A., Endo, T., Nakano, M. Effects of a mixture of organisms, *Lactobacillus acidophilus* or *Streptococcus faecalis* on  $\Delta 6$ -desaturase activity in liver of rats fed a fat- and cholesterol-enriched diet. *Nutrition*, **15**: 373-378 (1999)
- 90)** Fukushima, M., Matuda, T., Yamagishi, K., Nakano, M. Comparative hypocholesterolemic effects of six dietary oils in cholesterol-fed rats after long-term feeding. *Lipids*, **32**: 1069-1074 (1997)
- 91)** Fukushima, M., Takayama, Y., Habaguchi, T., Nakano, M. Comparative hypocholesterolemic effects of capybara (*Hydrochoerus hydrochaeris dabbebei*) oil, horse oil, and sardine oil in cholesterol-fed rats. *Lipids*, **32**: 391-395 (1997)
- 92)** Fukushima, M., Akiba, S., Nakano, M. Comparative hypocholesterolemic effects of six vegetable oils in cholesterol-fed rat. *Lipids*, **31**: 415-419 (1996)
- 93)** Fukushima, M., Nakano, M. Effects of lipid-saccharide complex and unsaponifiable matter from sunflowers on liver lipid metabolism and intestinal flora in rats. *Bioscience, Biotechnology, and Biochemistry*, **59**: 860-863 (1995)
- 94)** Fukushima, M., Nakano, M. Effects of sunflowers on lipid metabolism in rats. *Bioscience, Biotechnology, and Biochemistry*, **58**: 2278-2280 (1994)
- 95) Nakano, M., Fukushima, M. Formation of polycyclic aromatic hydrocarbons (PAHs) in lamb during roasting. *Journal of Food Hygienic Society of Japan*, **35**: 41-45 (1994)
- 96) Fukushima, M., Nakano, M., Endo, T., Negishi, T. Determination of prostaglandins in the

colostrums of dairy cattle by thermospray high-performance liquid chromatography-mass spectrometry. *Analytical Science*, **9**: 631-635 (1993)

- 97) Negishi, T., Nakano, M., Yanai, K., Kim, CH., Fukushima, M. Isolation and identification of  $\beta$ -nitrostyrene from smoked chicken. *Environmental Pollution*, **50**: 279-283 (1988)

#### 著書および総説

- 1) 福島道広:食品因子による栄養機能制御, 第1編第2章 難消化性糖類の機能性, 建帛社, pp.28-40 (2015)
- 2) 福島道広:食品機能性成分の吸収・代謝機構, 第3章 5多糖( $\beta$ -グルカン, イヌリン, レジスタントスターチ), シーエムシー出版, pp140-151 (2013)
- 3) 福島道広:わかりやすい食品機能栄養学, 第1章 炭水化物, 三共出版, pp.1-23 (2010)
- 4) 福島道広:食による生体機能調節の新展開, 第II章 食品の摂取とコレステロール代謝, 日本食品出版株式会社, pp73-86 (2002)
- 5) 福島道広:難消化性澱粉の腸内発酵および脂質代謝に関する研究, *ルミナコイド研究*, **17**: 1-10 (2013)
- 6) 福島道広, 大庭潔:デンプン工場から排出される有用物質としてのポテトペプチドの機能性, *化学と生物*, **49**:468-473 (2011)
- 7) 福島道広, 中村有美, 李スルギ, 土平洋彰, 小林由佳, 川上秋桜, 岡田朋子, 島田謙一郎, 韓圭鎬:機能性糖質の研究の動向について-とくに機能性糖質のプレバイオティクス効果について-, *日本消化吸収学会誌*, **33**:202-215 (2010)
- 8) 福島道広, 岡田朋子, 韓圭鎬:煮豆の効果-雑豆に含まれる難消化性澱粉は腸内環境及び脂質代謝を改善させる?- , *日本食物繊維学会誌*, **13**:75-83 (2009)
- 9) 福島道広:煮マメの効能-難消化性澱粉はコレステロールを低下させる?- , *化学と生物*, **42**: 359-364 (2004)

#### (3) 過去5年間の本学会での活動状況

本部・支部役員

理事(平成26年～現在)

参与(平成24～現在)

学会活動強化委員会副委員長(平成28年～平成29年)

学会活動強化委員会委員長(平成30年～現在)

北海道支部支部長(平成24年～現在)

#### 大会講演・座長

第73回日本栄養・食糧学会大会講演・シンポジウム講演・座長(令和元年)

第72回日本栄養・食糧学会大会講演・座長(平成30年)

第71回日本栄養・食糧学会大会講演(平成29年)

第70回日本栄養・食糧学会大会講演・座長(平成28年)

第69回日本栄養・食糧学会大会講演(平成27年)

#### (4) 特記事項

平成 15 年 日本農芸化学会, 北海道支部奨励賞「食品の摂取によるコレステロール代謝に関する研究」

平成 18 年 日本油化学会, 論文賞「Fat- and cholesterol-enriched diet feeding affects gene expression related to cholesterol metabolism in rats」

平成 24 年 日本食物繊維学会, 学会賞「難消化性澱粉の腸内発酵及び脂質代謝に関する研究」