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Preventive effects of purple potato in obesity and low-grade inflammation

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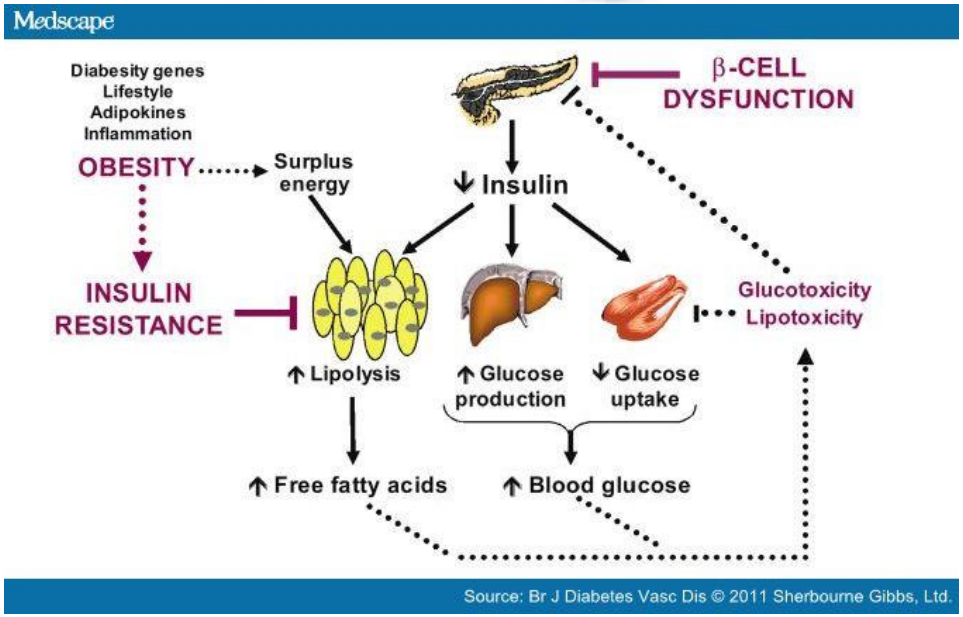
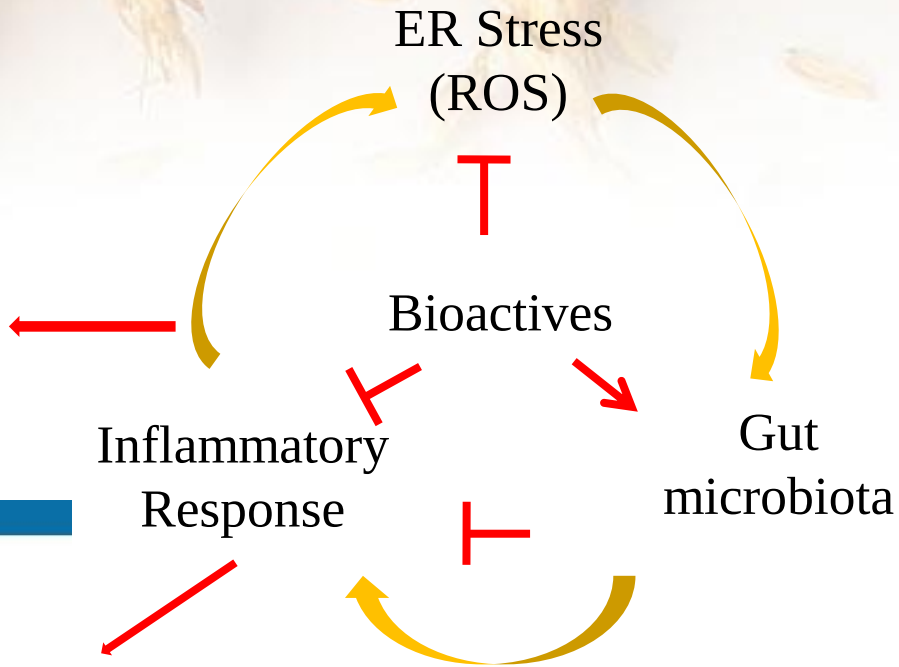
Canada

Alternative approach-food bioactives





(Adapted from Bhattacharyya *et al*.,(2014)

Chronic Diseases are the major cause of death

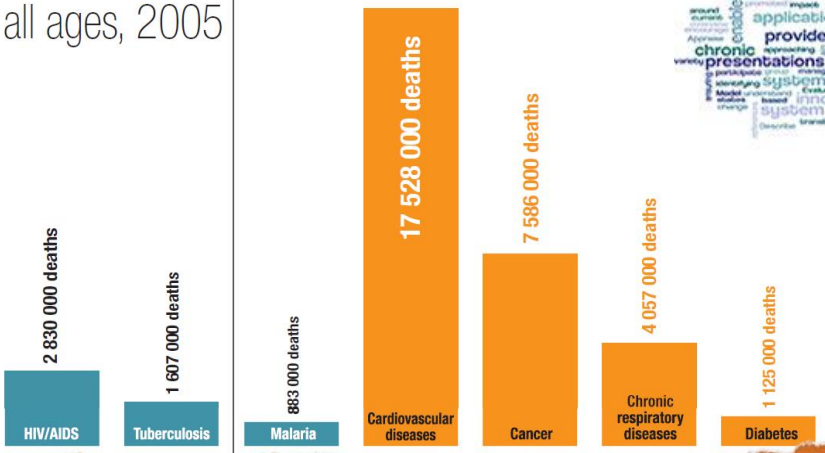
Chronic diseases include heart disease, stroke, cancer, chronic respiratory diseases and diabetes. Visual impairment and blindness, hearing impairment and deafness, oral diseases and genetic disorders are other chronic conditions that account for a substantial portion of the global burden of disease.

From a projected total of 58 million deaths from all causes in 2005,[1] it is estimated that chronic diseases will account for 35 million, which is double the number of deaths from all infectious diseases (including HIV/AIDS, tuberculosis and malaria), maternal and perinatal conditions, and nutritional deficiencies combined.

[1] The data presented in this overview were estimated by WHO using standard methods to maximize cross-country comparability. They are not necessarily the official statistics of Member States.

35 000 000 people will die from chronic diseases in 2005

Projected global deaths by cause, all ages, 2005



60% of all deaths are due to chronic diseases

UNDERLYING SOCIOECONOMIC, CULTURAL, POLITICAL AND ENVIRONMENTAL DETERMINANTS	COMMON MODIFIABLE RISK FACTORS	INTERMEDIATE RISK FACTORS	MAIN CHRONIC DISEASES
Globalization	Unhealthy diet	Raised blood pressure	Heart disease
Urbanization	Physical inactivity	Raised blood glucose	Stroke
Population ageing	Tobacco use	Abnormal blood lipids	Cancer
	NON-MODIFIABLE RISK FACTORS	Overweight/obesity	Chronic respiratory diseases
	Age		Diabetes
	Heredity		

http://www.who.int/chp/chronic_disease_report/full_report.pdfl Accessed March 5, 2018

Diet and chronic disease prevention

HEALTH CARE COST SAVINGS

Dietary Supplements for Smart Prevention

A new economic report shows that taking specific dietary supplements can provide significant individual and societal healthcare savings, by reducing the number of hospitalizations and other costly medical events associated with chronic diseases. The report looked at eight dietary supplement regimens and four conditions in a targeted population of U.S. adults 55+ who have the specific conditions or are at high risk for the disease.

	CORONARY HEART DISEASE (CHD)	DIABETES & CHD	AGE-RELATED EYE DISEASE (ARED)	OSTEOPOROSIS**
Supplements as interventions Taking any of these eight dietary supplements at preventive intake levels* has been shown to reduce the occurrence of medical events related to these four diseases in high risk populations.	B VITAMINS, PHYTOSTEROLS, OMEGA-3, PSYLLIUM DIETARY FIBER	CHROMIUM PICOLINATE	LUTEIN & ZEAXANTHIN	CALCIUM & VITAMIN D, MAGNESIUM
Event rate % of targeted population that will experience a medical event per year. Source: Centers for Disease Control and Prevention	16%	12%	33%	15%
Relative risk reduction The risk of having a medical event is reduced by taking these supplements.	3.3% TO 11.5%	10.2%	AMD Age-related Macular Degeneration 23.0%; Cataracts 15.3%	6.0% TO 18.6%
2013–2020 Cumulative Stats **Medical events avoided** The number of medical events avoided between 2013–2020 if the targeted population used these supplements at preventive intake levels.	808,000 TO 2,337,000	650,000	115,000; 7,659,000	548,000 TO 1,208,000
Avoided expenditures with supplementation	$12.1 – $35.1 billion	$9.8 billion	$31.0 billion	$6.8 – $15.0 billion
Net savings after cost of supplements	$3.9 – $26.6 billion	$7.8 billion	$7.7 billion	$4.8 – $12.2 billion
Savings yet to be realized if targeted population takes supplements at preventive intake levels	$2.8 – $26.5 billion	~$7.8 billion***	$7.4 billion	$4.2 – $8.6 billion

Notes: *Preventive intake levels identified in full report. **Dietary supplement regimens for osteoporosis apply only to women 55 and over ***With less than 1% currently using this supplement, nearly all of the net savings has yet to be realized. **Source:** *Smart Prevention—Health Care Cost Savings Resulting from the Targeted Use of Dietary Supplements*—Frost & Sullivan, www.frost.com

www.supplementforsmartprevention.org
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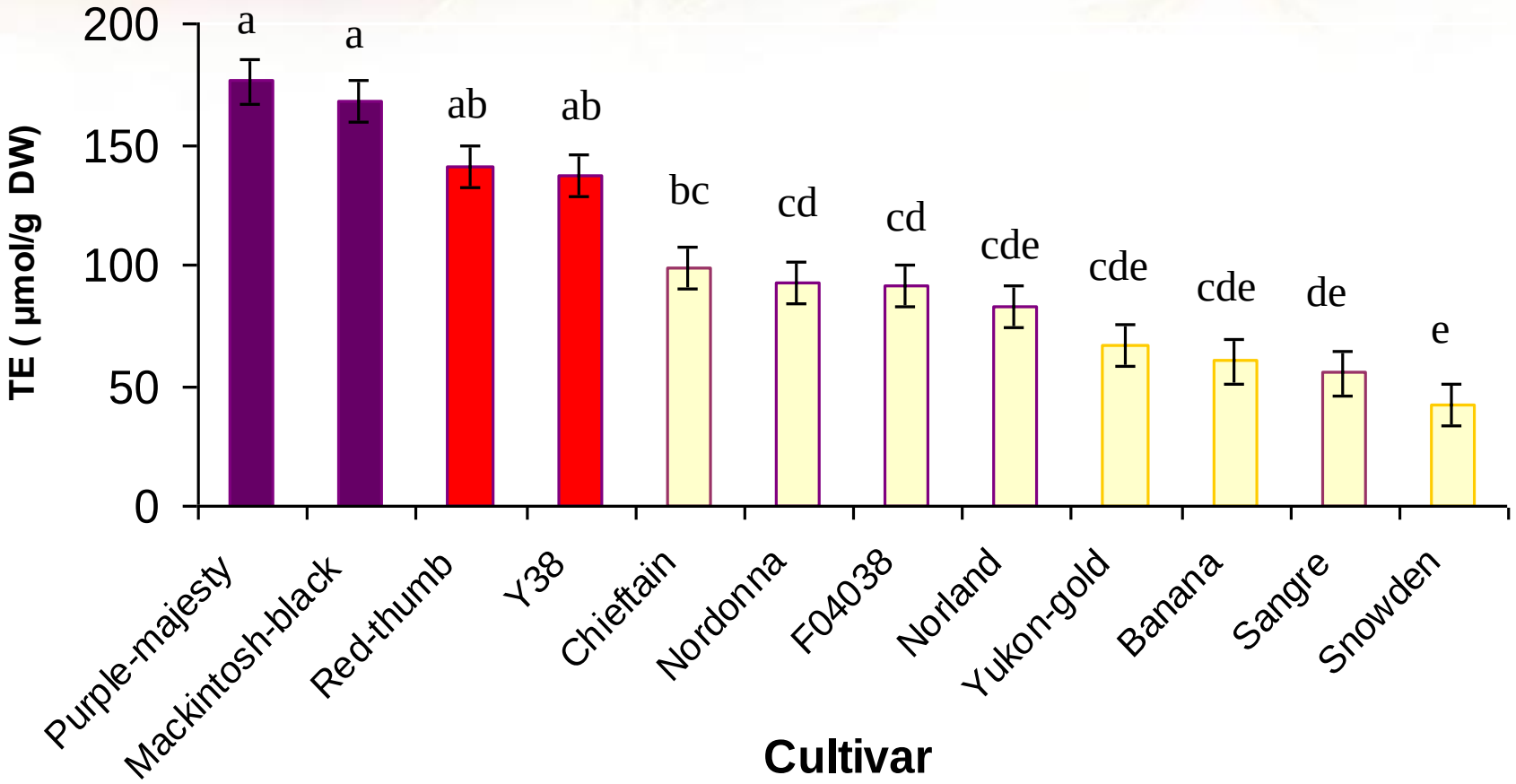
Antioxidant Capacity (ORAC)

potato

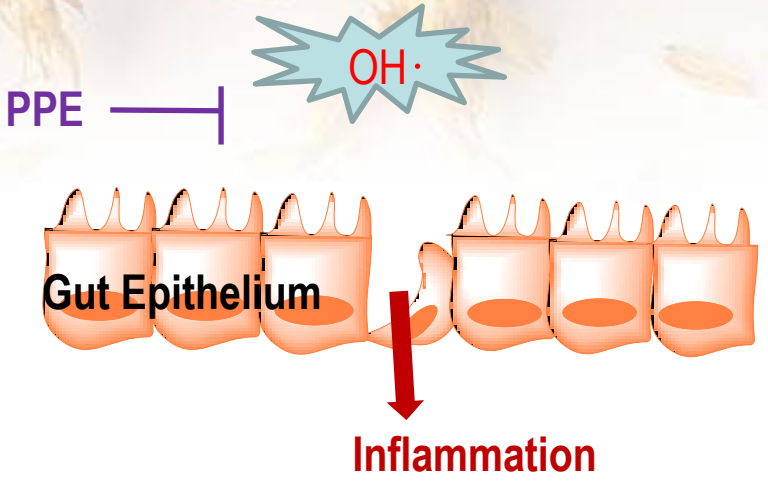
Antioxidant capacity (ORAC) of 12 potato cultivars

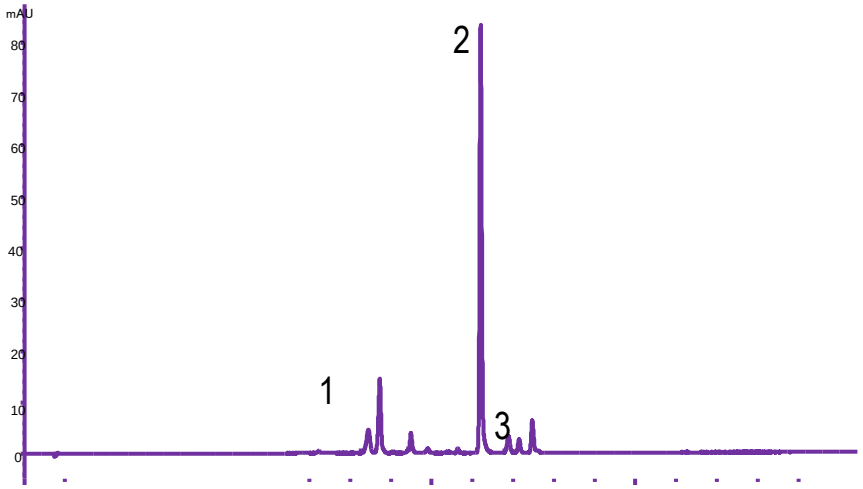


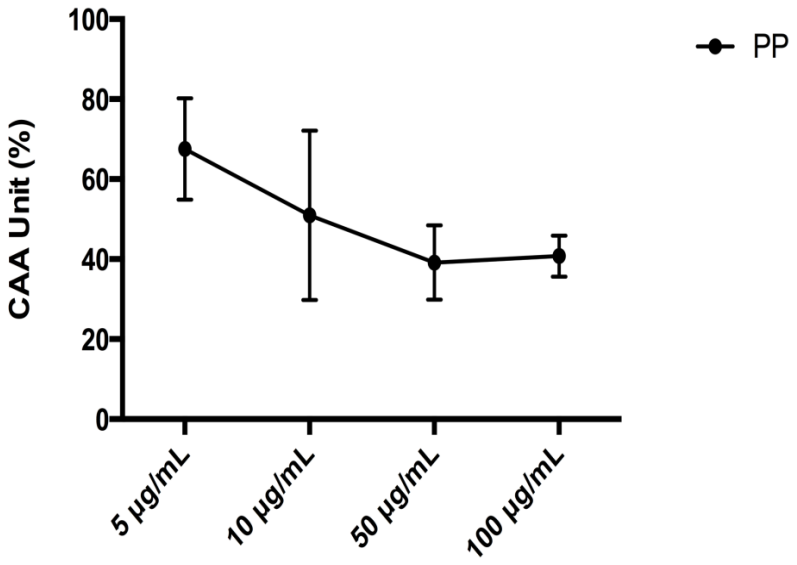
Can. J. Plant Sci. 2012, 92: 485-493

High antioxidant content and activity

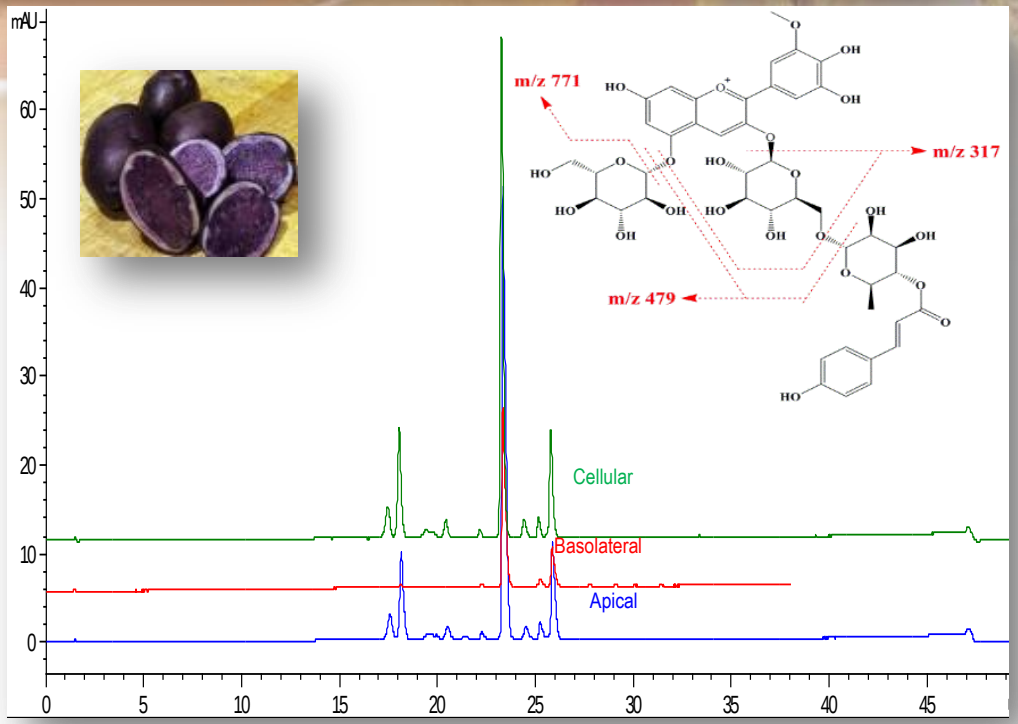
Anthocyanins PPE	mg/100g DW
1 pelargonidin	2.88±0.01
2 petunidin	**15.27±1.72**
3 malvidin	1.84±0.04
TAC	39.0±0.03

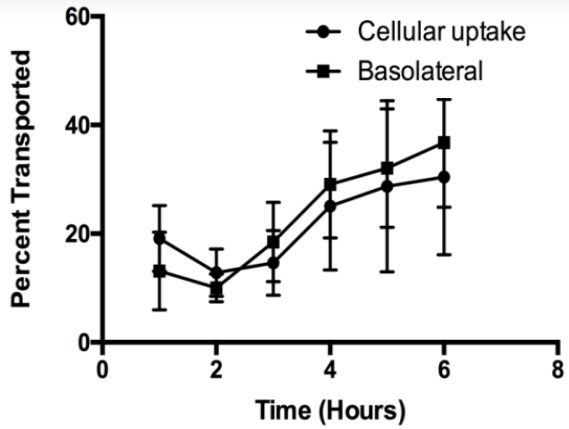




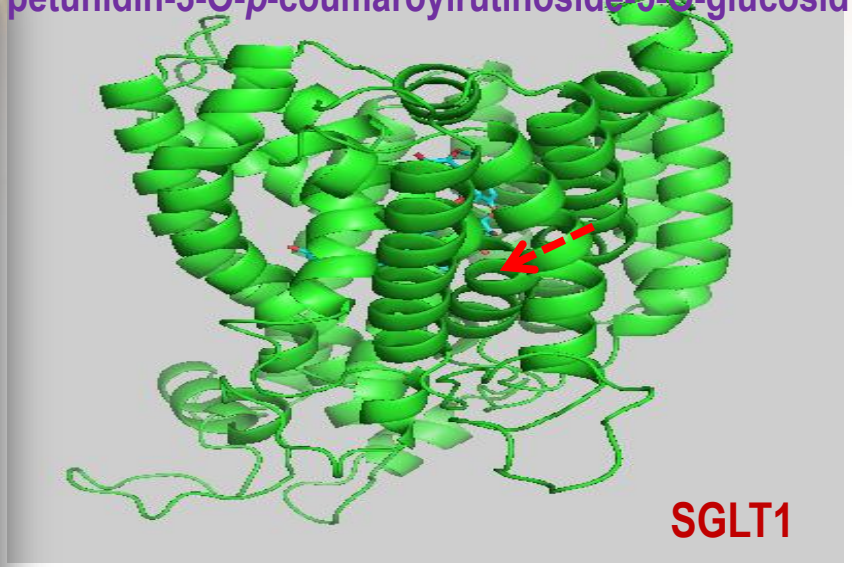


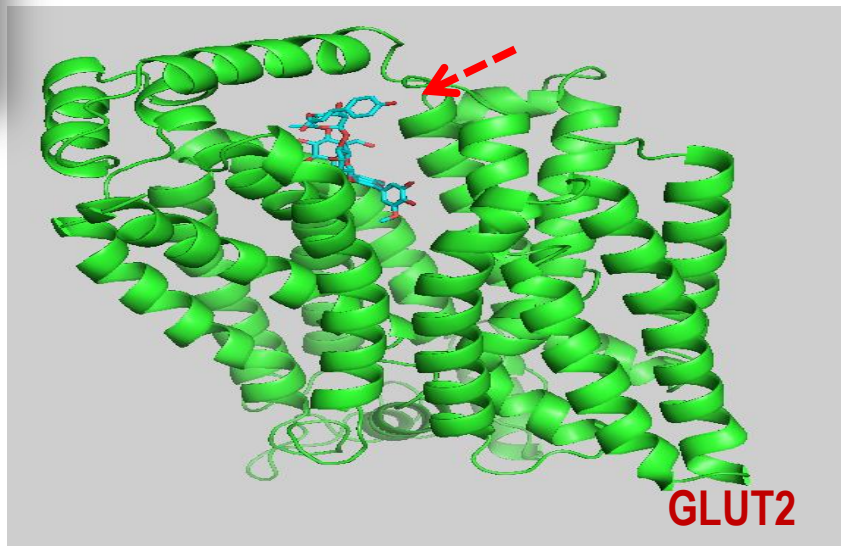
Molecular docking of purple carrot or potato derived anthocyanins to SGLT1 or GLUT2





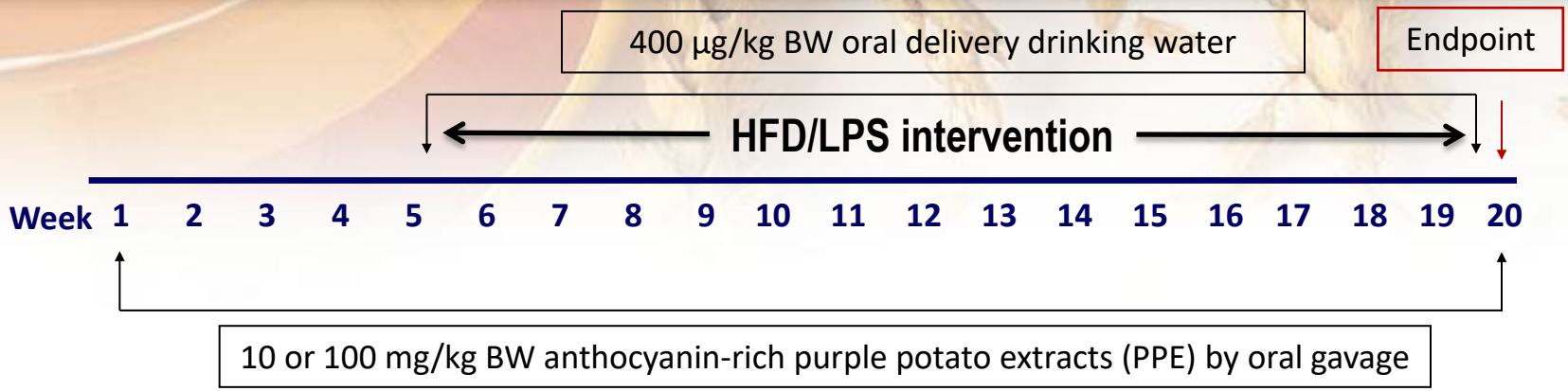
petunidin-3-O-*p*-coumaroylrutinoside-5-O-glucosid





Zhang et al. Mol Nutr Food Res. 2017

Animal model of low-grade inflammation and obesity



Mouse model:
16 weeks old female C-57Bl-6
12 mice/group

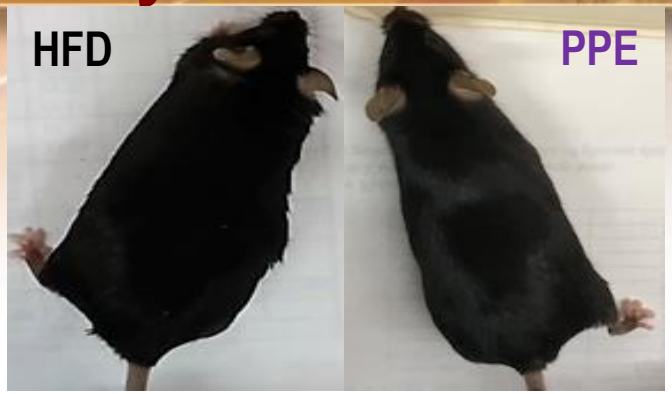
Diet:
Normal diet (14% protein) and high fat diet

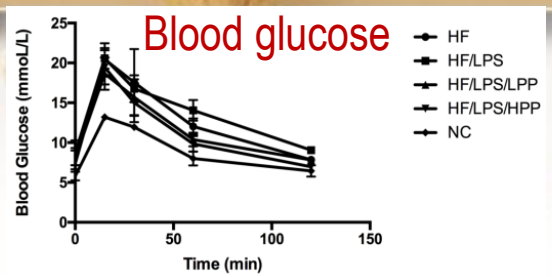
Oral Drinking water

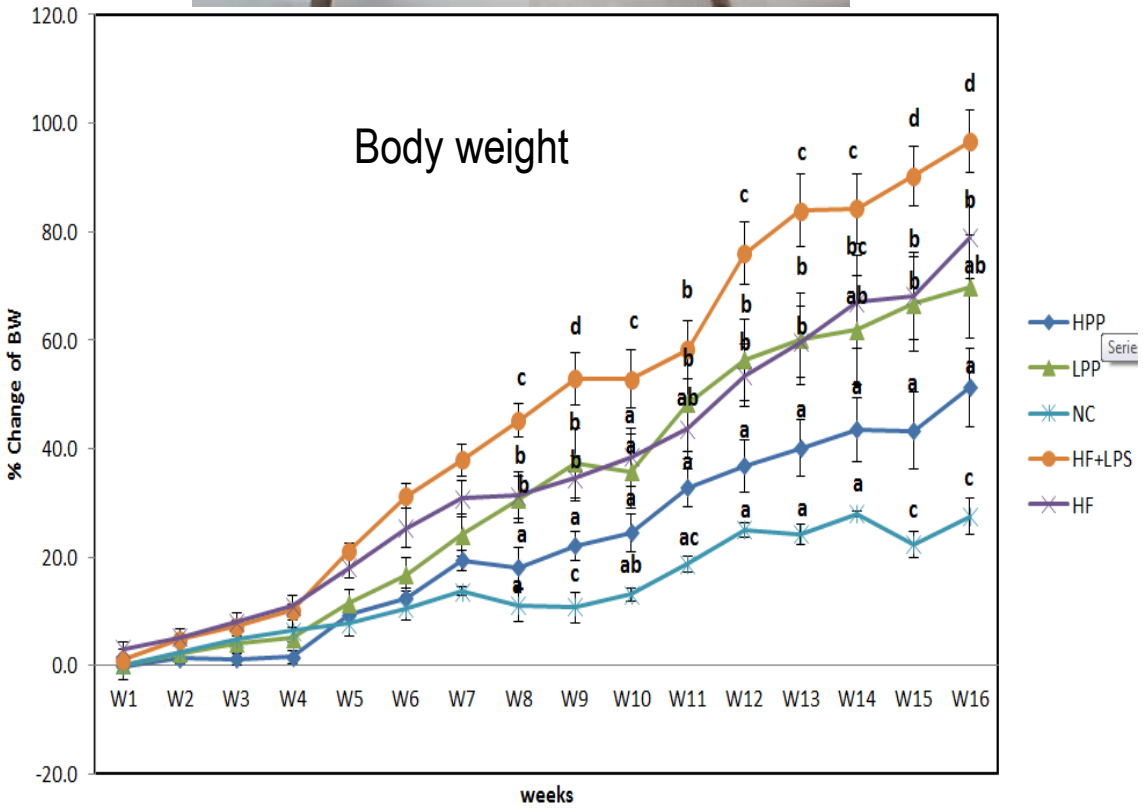
During trial
- Body weight – Weekly
- Food Consumption – Weekly
- Presence of endotoxin in blood
- Blood glucose-ENDPOINT

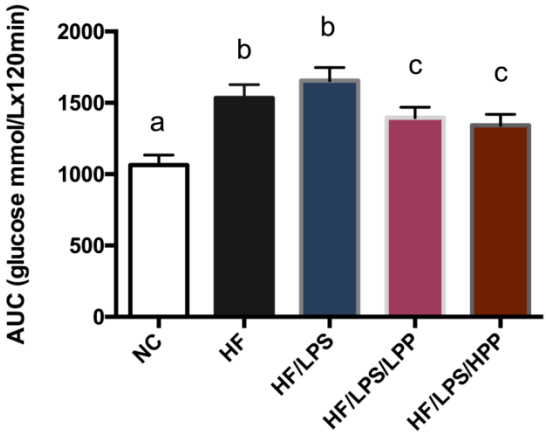
Animal groups: Negative control (NCN), PPE-HFD (NC), Positive control/HFD/LPS(PC/HFD), PPE-Low/HFD/LPS (PPL), PPE-High/HFD/LPS(PPH)

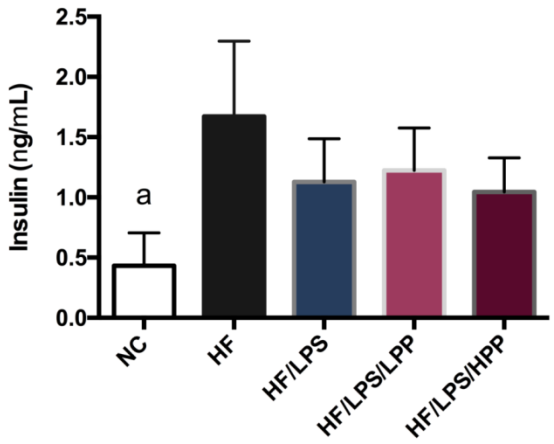
Effect of purple potato-derived anthocyanins on obesity











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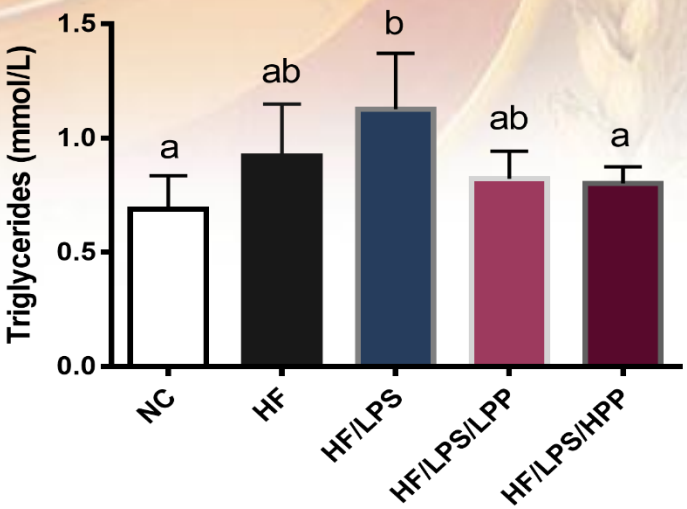
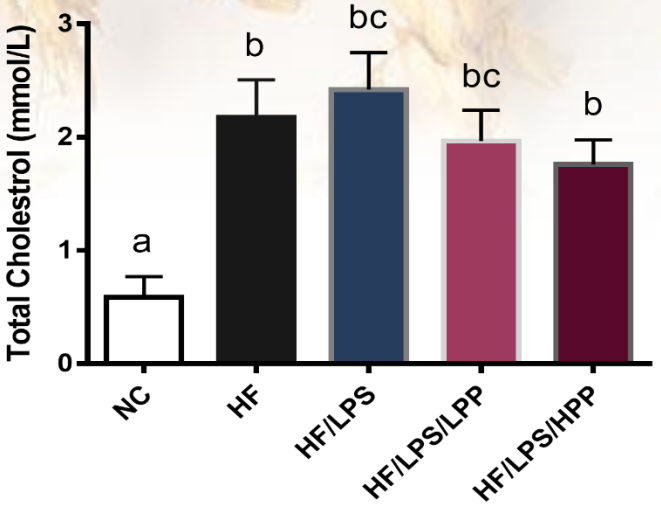
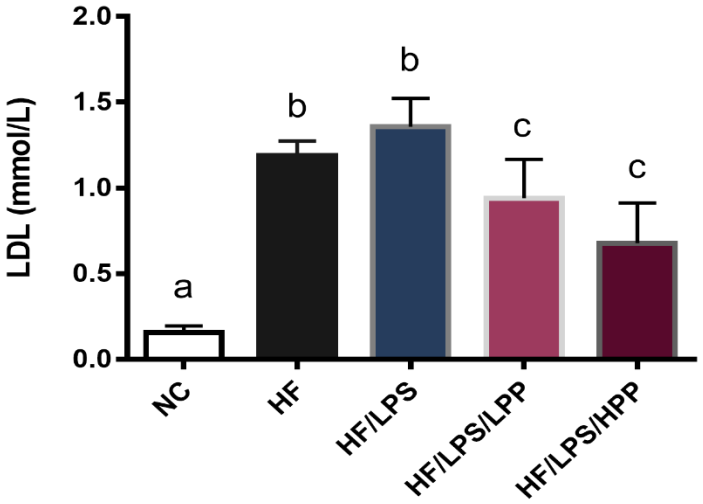
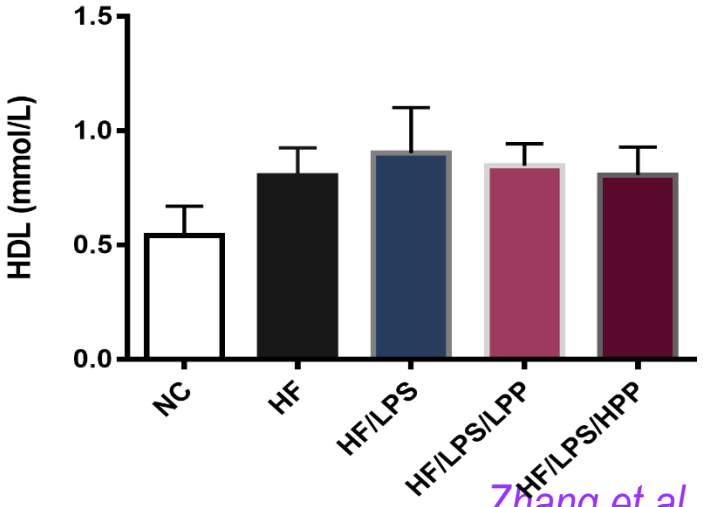
Effect of purple potato-derived anthocyanins on blood lipid profile









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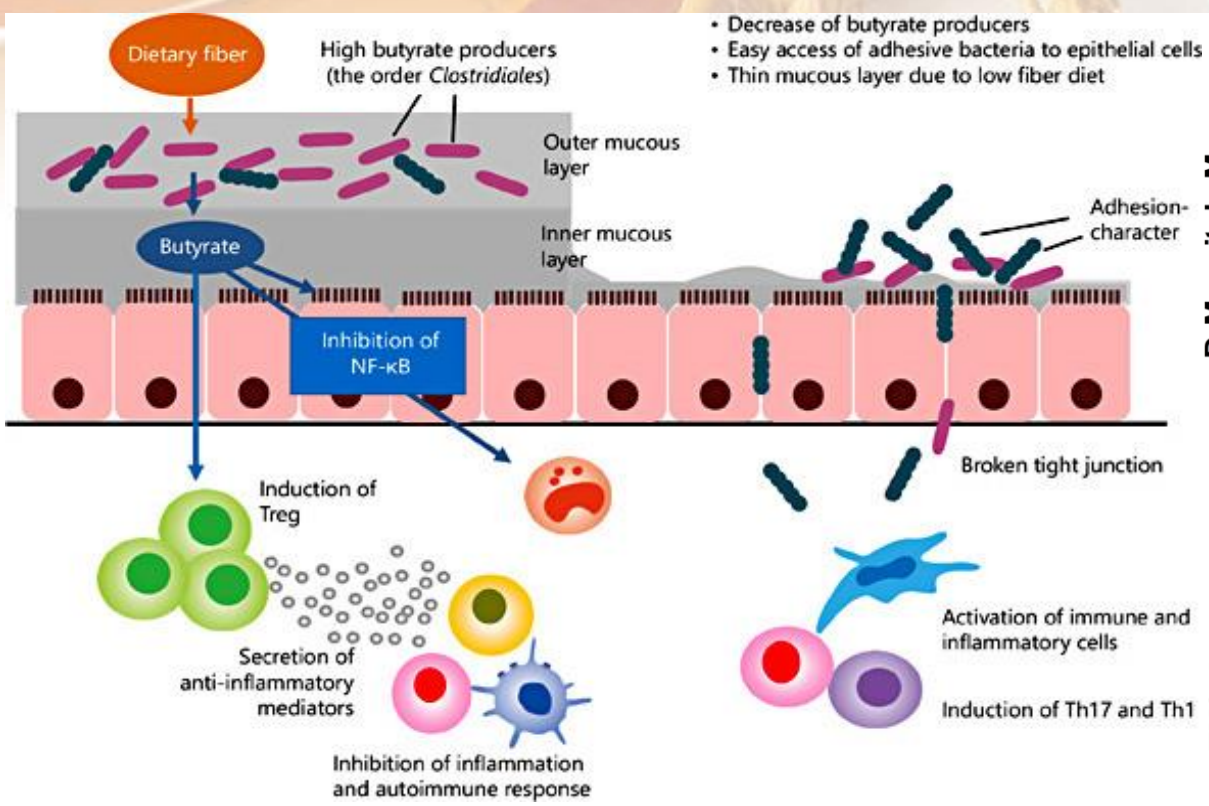
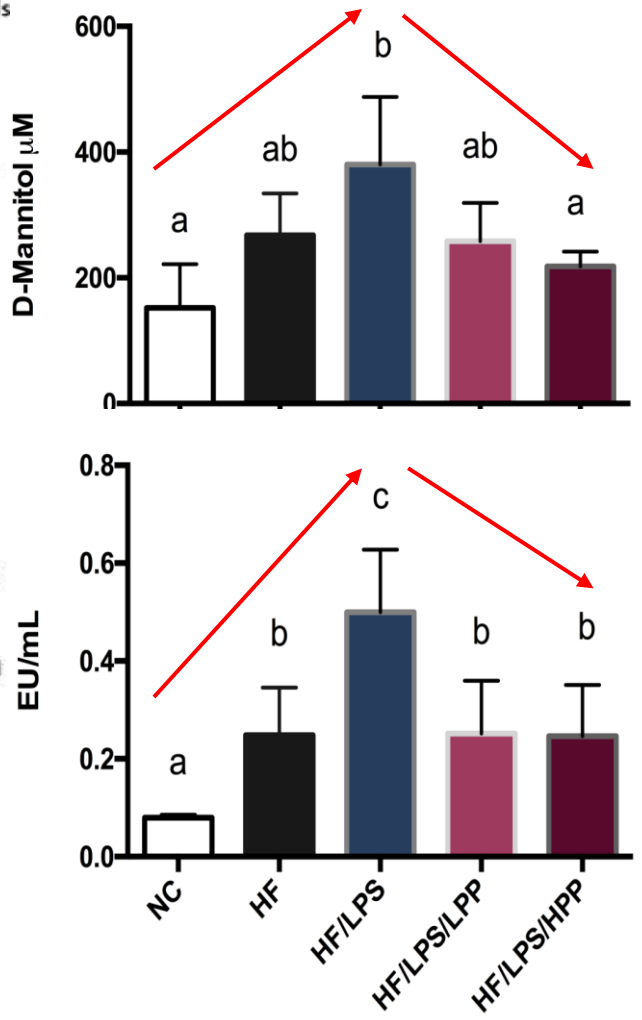
Effect of purple potato-derived anthocyanins on gut leaking (plasma D-mannitol & endotoxin)



Andoh A.2016. Digestion;93:176-181



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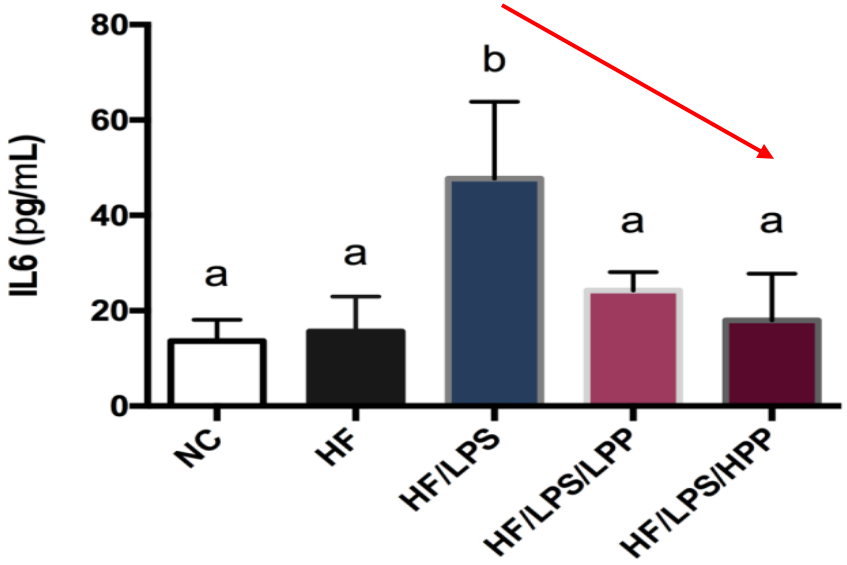
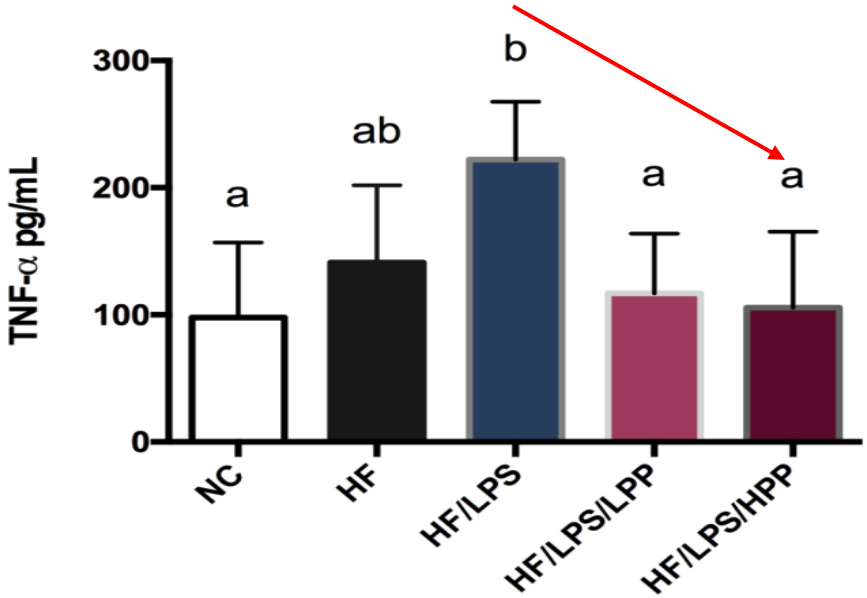
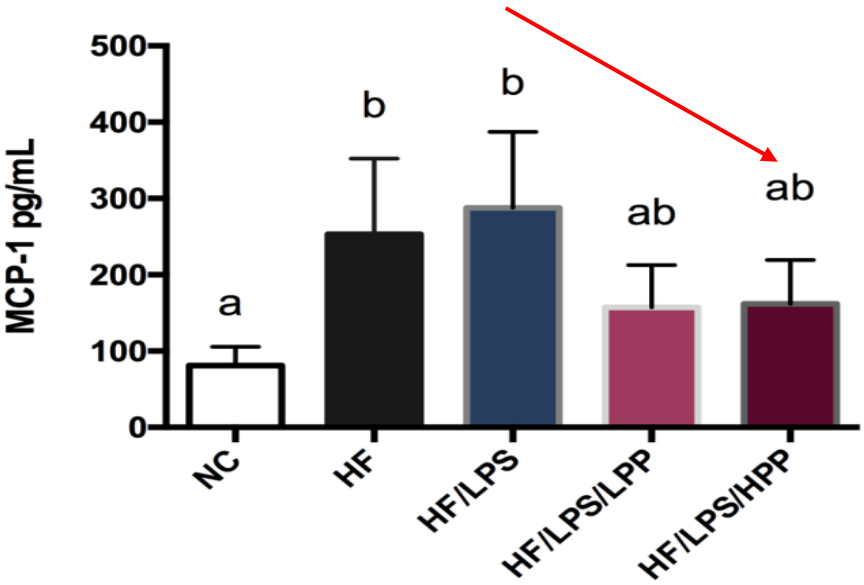
Purple potato extracts reduce systemic inflammation







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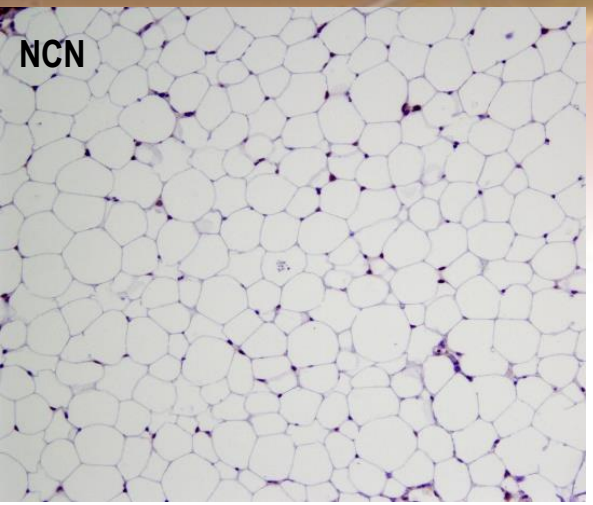
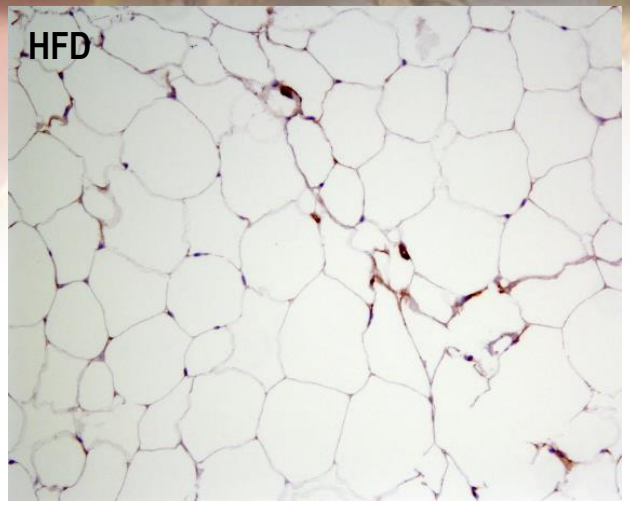
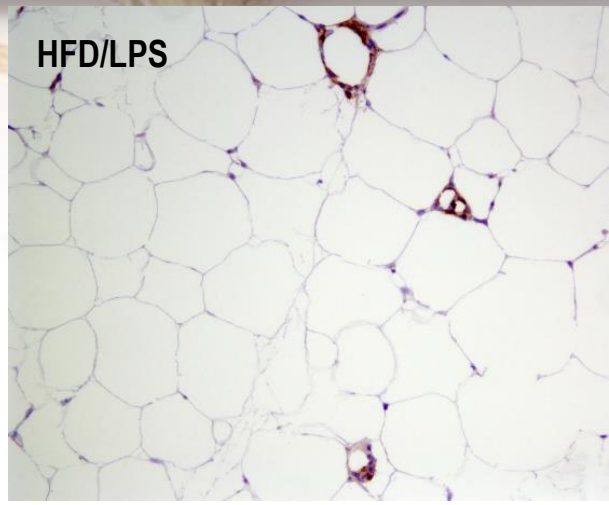
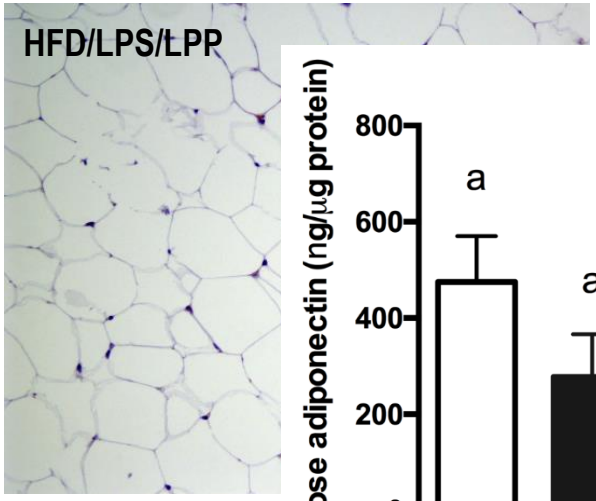
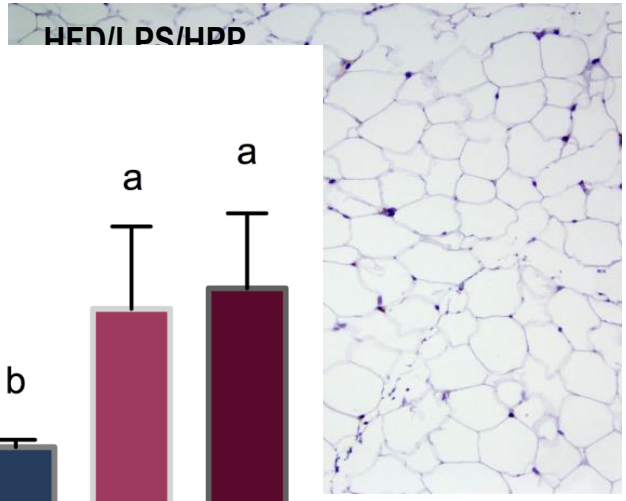
Purple potato extracts prevent inflammation in White adipose tissue (WAT)

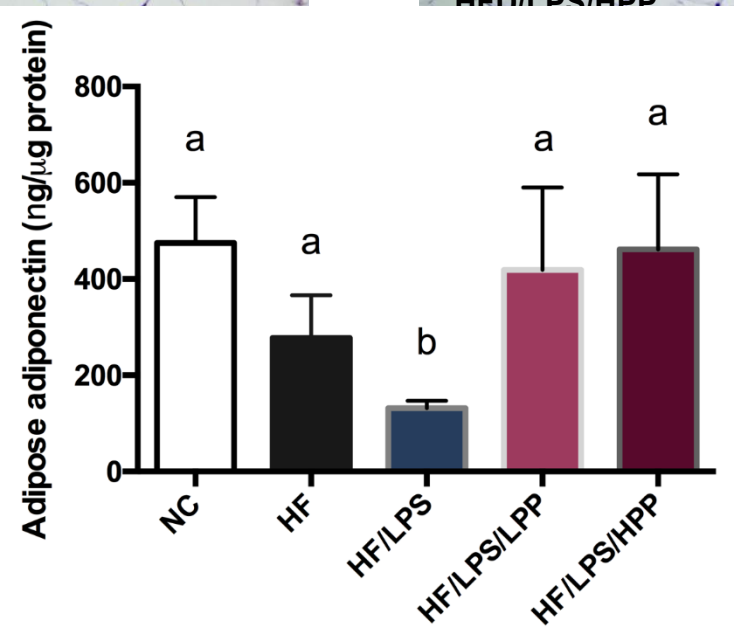












Effect of purple potato-derived anthocyanins on gut integrity and immune responses

Jejunum	NC	HFD	HFD/LPS	LPP	HPP
ZO-1	136.0±28.68a	1.32±0.42b	0.73±0.28b	48.21±13.11a	155.54±31.39a
JAMA	194.0±14.49a	2.15±0.86b	1.36±0.64b	164.23±22.17a	195.80±44.19a
Claudin3	4.15±0.70a	1.26±0.35b	1.14±0.28b	1.96±0.30b	2.22±0.31b

- Colonic barrier & immune dysfunction

Colon	NC	HFD	HFD/LPS	LPP	HPP
ZO-1	7.69 ± 1.38^{a}	1.30 ± 0.41^{b}	2.5 ± 0.81^{b}	5.61 ± 1.05^{a}	7.51 ± 1.64^{a}
JAMA	1.57 ± 0.15^{a}	0.91 ± 0.09^{b}	0.97 ± 0.05^{b}	1.19 ± 0.2^{b}	1.69 ± 0.11^{a}
Claudin1	3.56 ± 0.49^{a}	0.98 ± 0.32^{b}	1.31 ± 0.06^{b}	3.05 ± 0.71^{a}	3.38 ± 0.64^{a}
Claudin3	3.62 ± 0.44^{a}	1.56 ± 0.37^{a}	1.22 ± 0.24^{b}	2.71 ± 0.42^{a}	2.78 ± 0.65^{a}
Occludin	6.97 ± 1.05^{a}	1.80 ± 0.5^{b}	1.38 ± 0.33^{b}	4.27 ± 1.0^{b}	6.11 ± 0.82^{a}
Muc2	1.13±0.2	0.93±0.34	0.85±0.21	0.74±0.17	1.52±0.32
MCP-1	1.37 ± 0.38^{a}	1.22 ± 0.12^{a}	3.04 ± 0.66^{b}	0.42 ± 0.19^{a}	0.5 ± 0.16^{a}
TNF-α	1.06 ± 0.13^{a}	2.19 ± 0.38^{a}	3.72 ± 0.93^{b}	1.59 ± 0.31^{a}	0.87 ± 0.37^{a}
IL-6	1.21 ± 0.33^{a}	6.21 ± 1.9^{b}	7.38 ± 1.8^{b}	3.36 ± 2.35^{a}	1.62 ± 0.64^{a}
IL-1β	1.09 ± 0.22^{a}	41.18 ± 12.54^{b}	35.7 ± 9.64^{b}	8.30 ± 1.82^{a}	8.26 ± 1.83^{a}
IL-17A	1.25 ± 0.31^{a}	94.25 ± 19.90^{b}	111.17 ± 28.05^{b}	31.54 ± 25.52^{a}	15.43 ± 4.16^{a}
IL-10	1.6 ± 0.28^{a}	0.41 ± 0.09^{b}	0.146 ± 0.08^{b}	0.27 ± 0.24^{b}	1.09 ± 0.25^{a}

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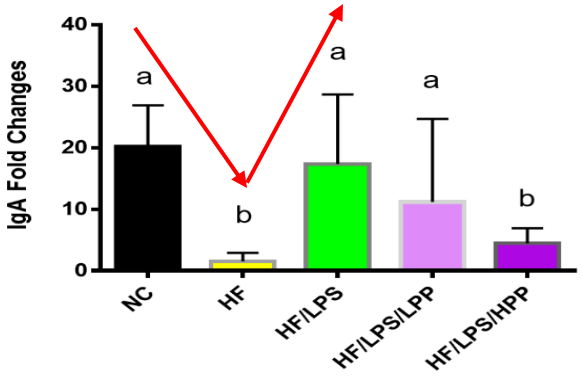
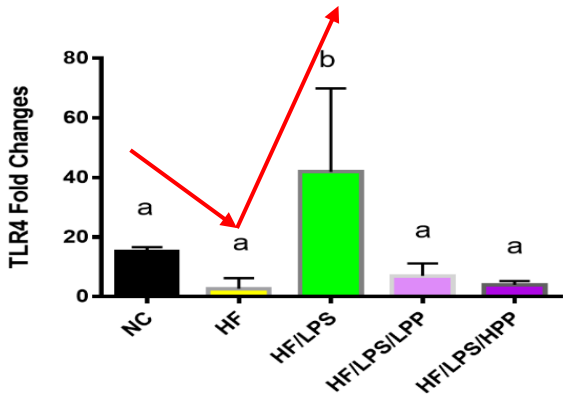
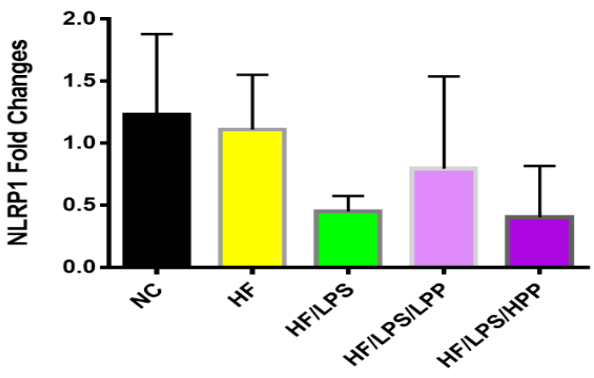
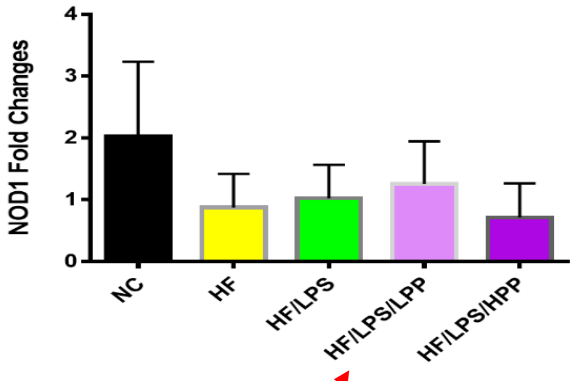
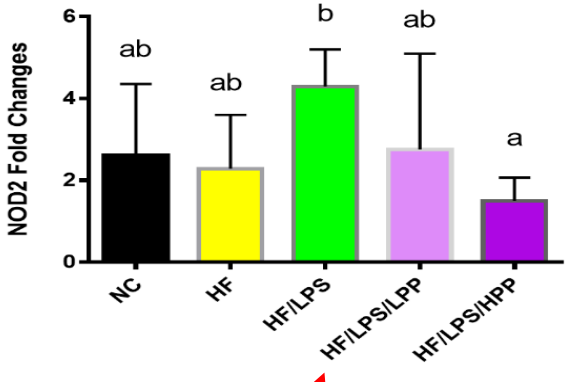
Purple potato extracts modulate gut sensing homeostasis

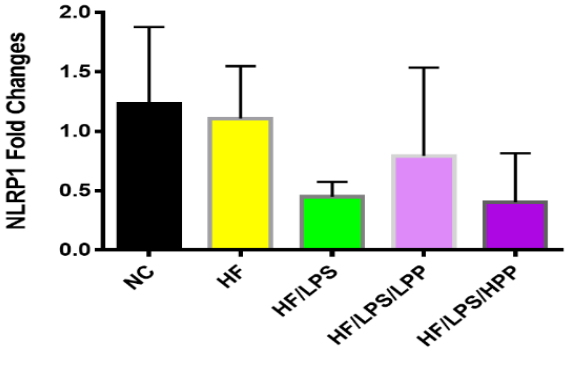


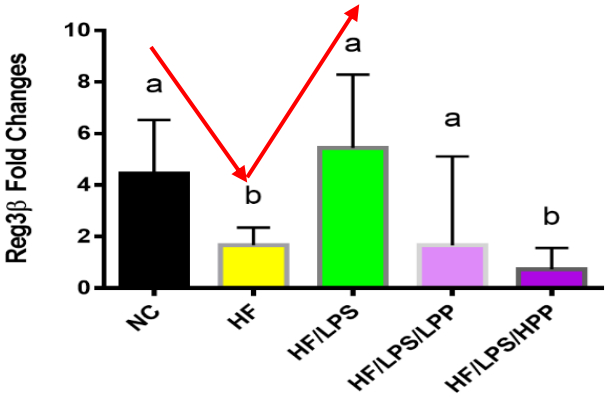


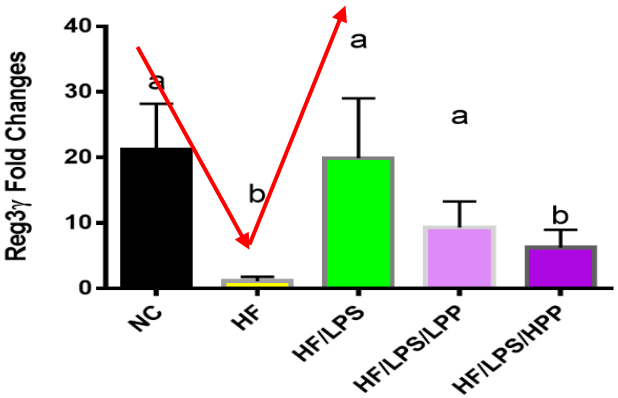


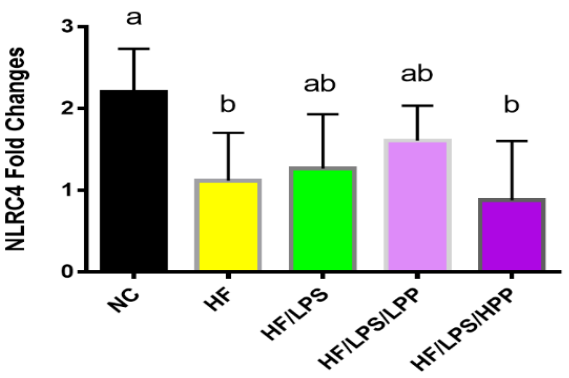




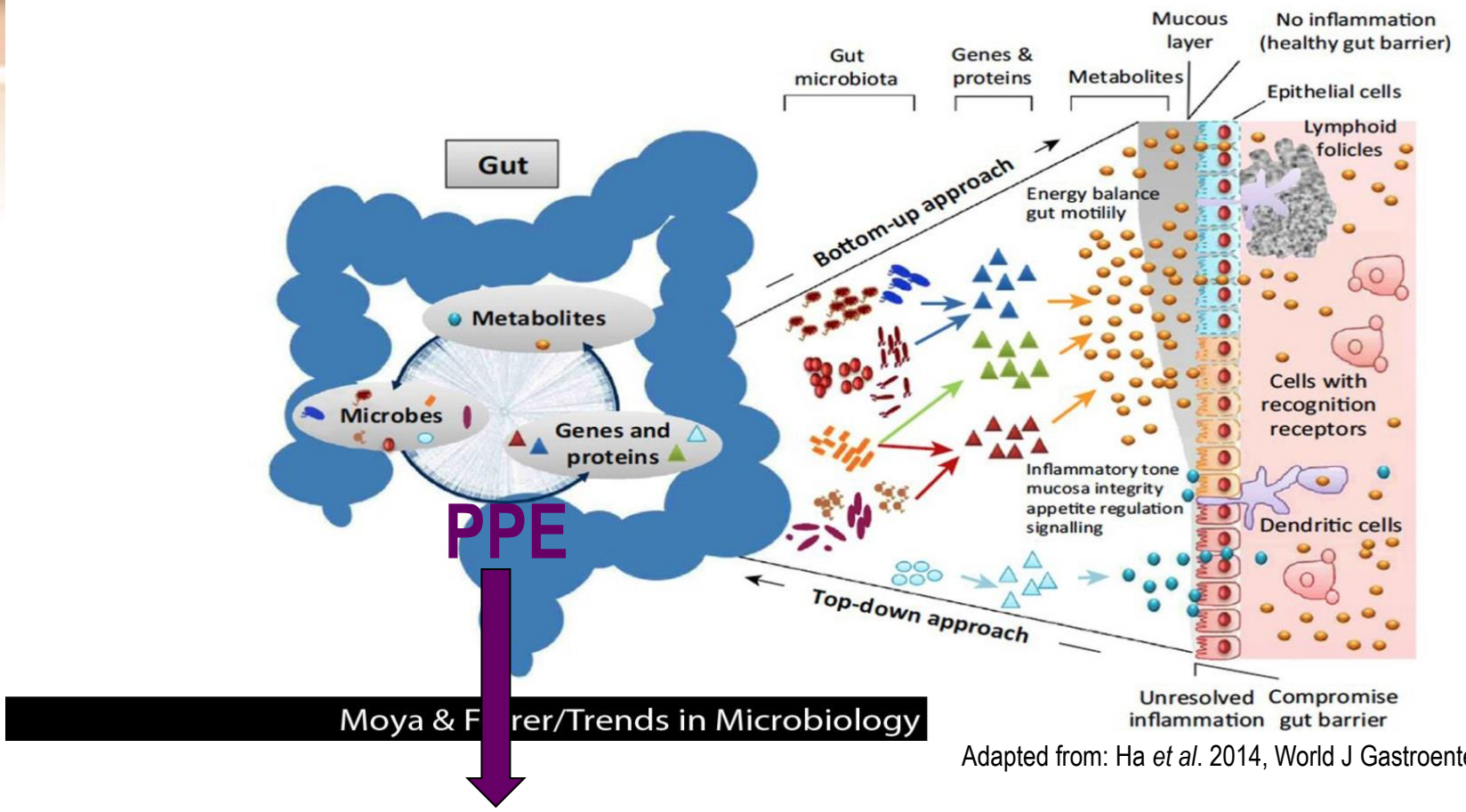








Implication of dietary purple potato extracts on integrity gut homeostasis

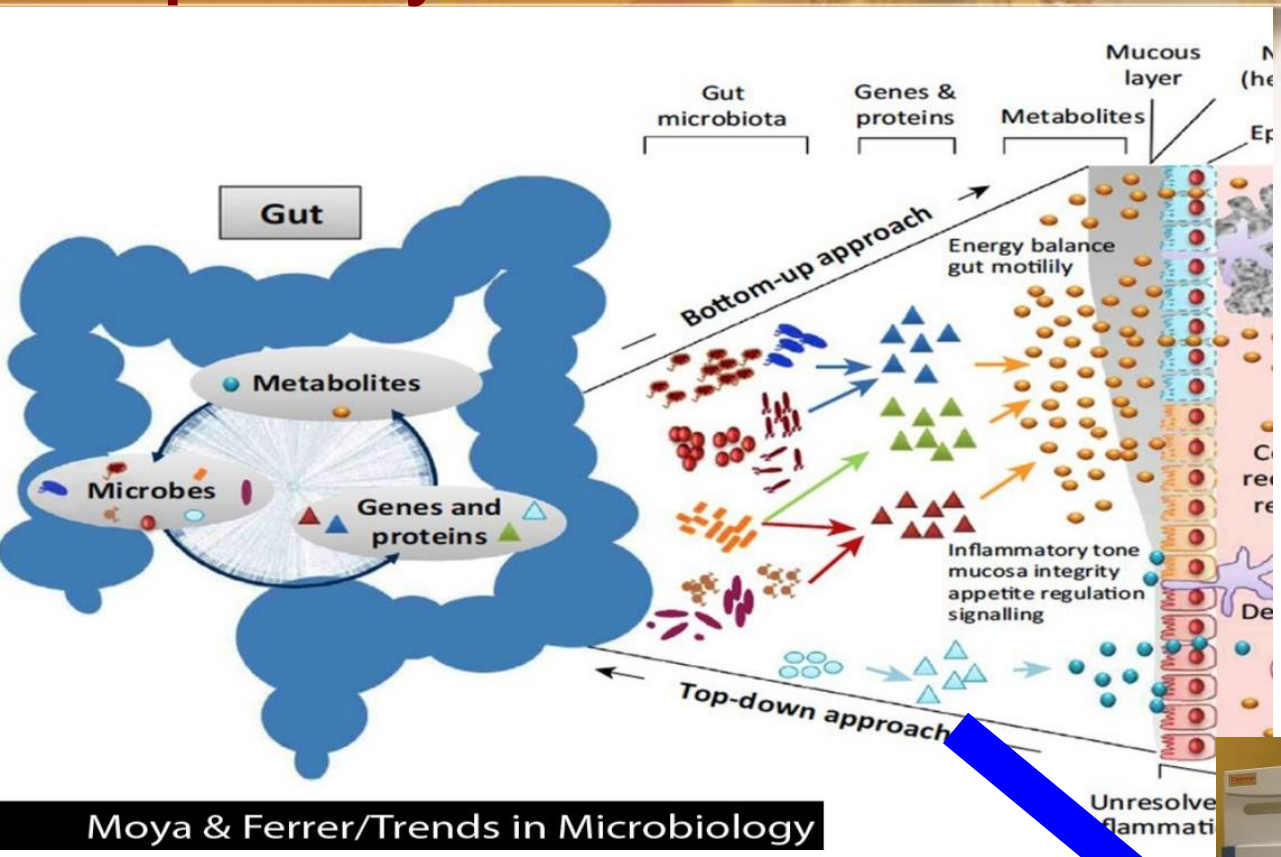


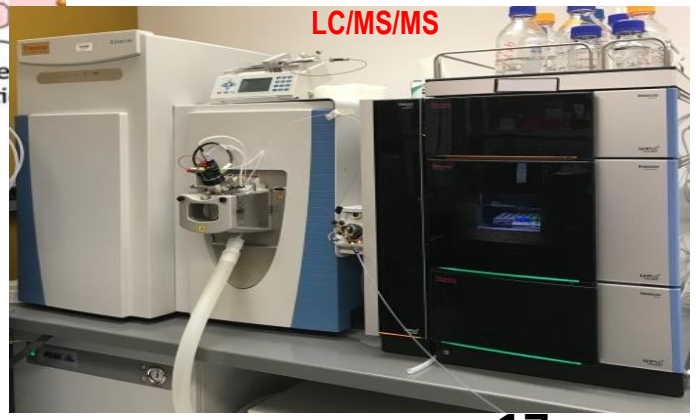
Adapted from: Ha *et al*. 2014, World J Gastroenterol. 24: 16498-517

- **Restore gut integrity**
- **Restore immune homeostasis**

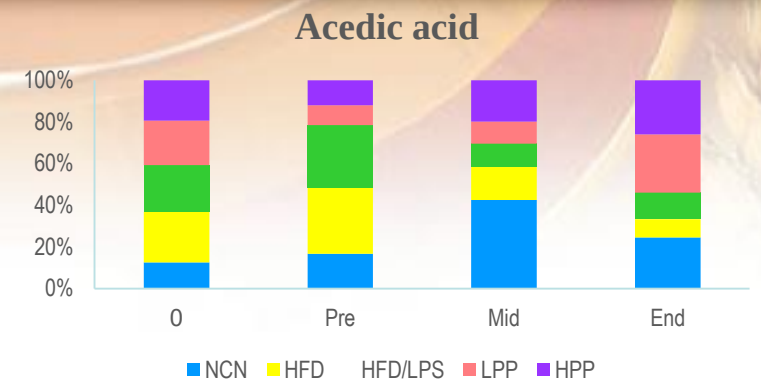
- **Restore blood glucose level Change blood lipid profile**
- **Prevent systemic inflammation**

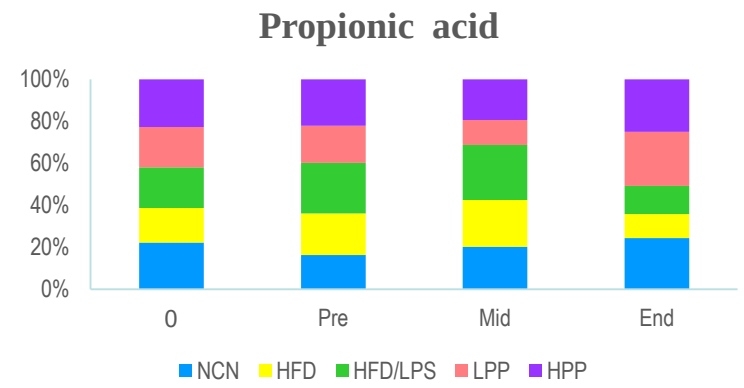
Purple potato extracts regulate metabolic pathway

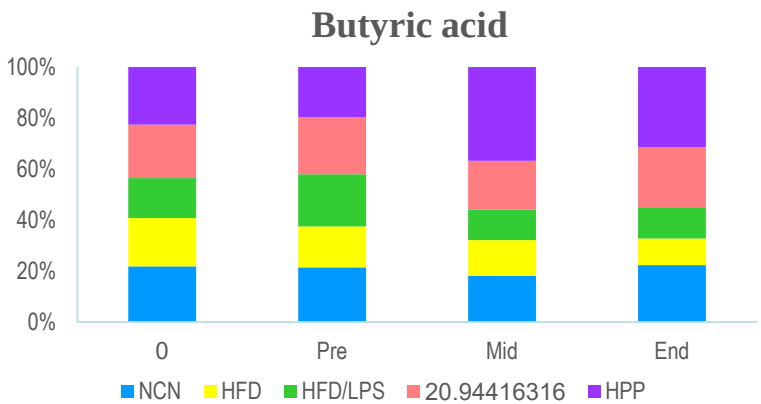


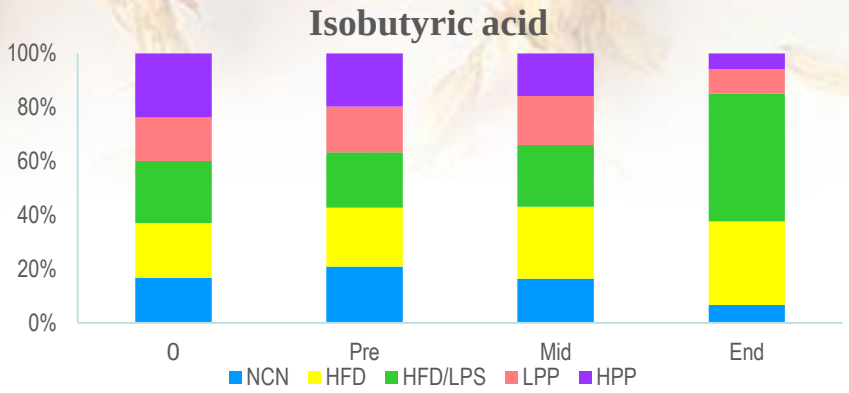


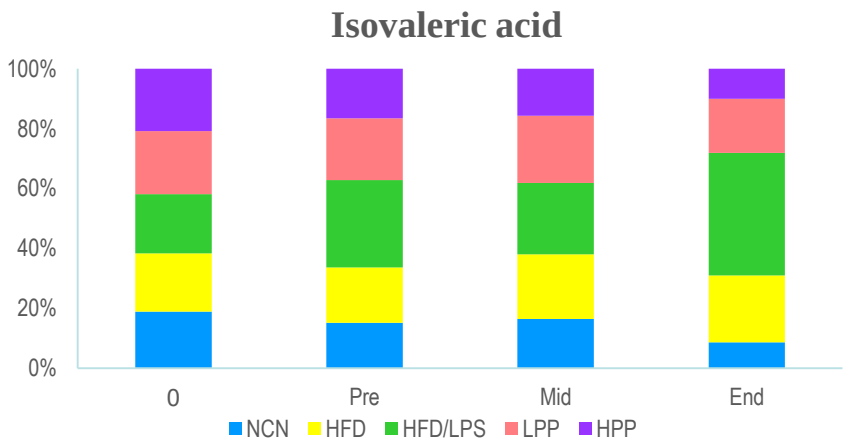
Purple potato extracts modulate fecal SCFA and BCFA distribution



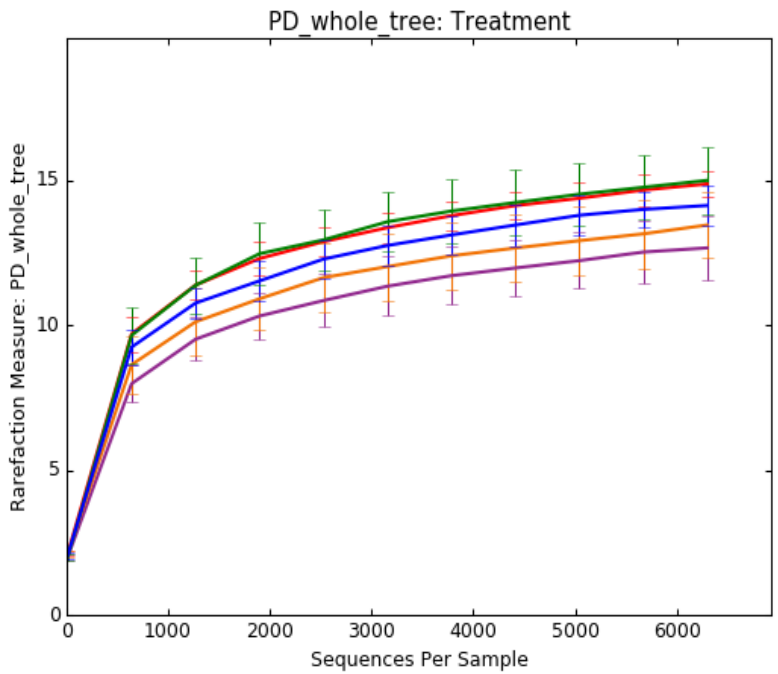




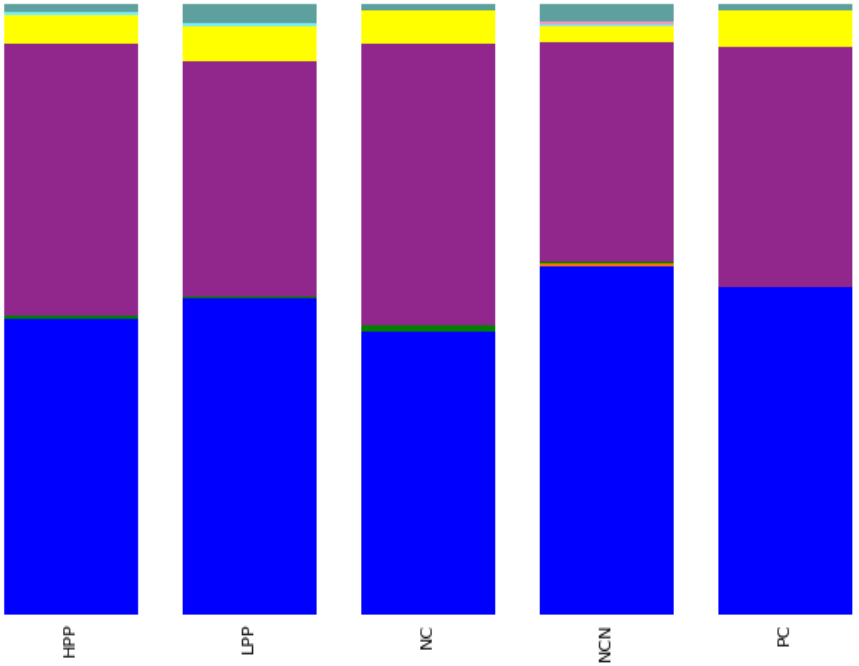




Purple potato extracts changes gut microbiota composition



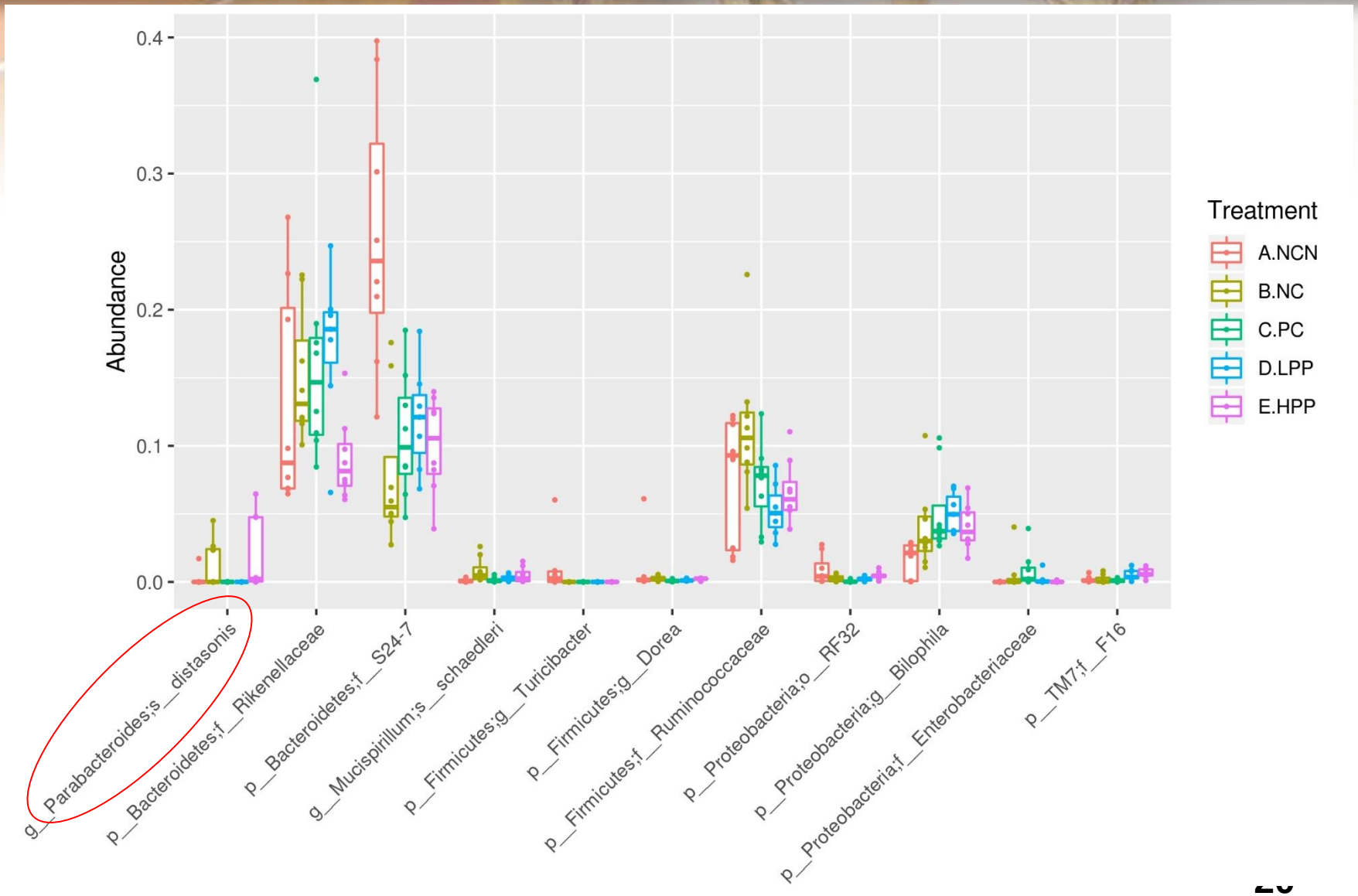
α-diversity



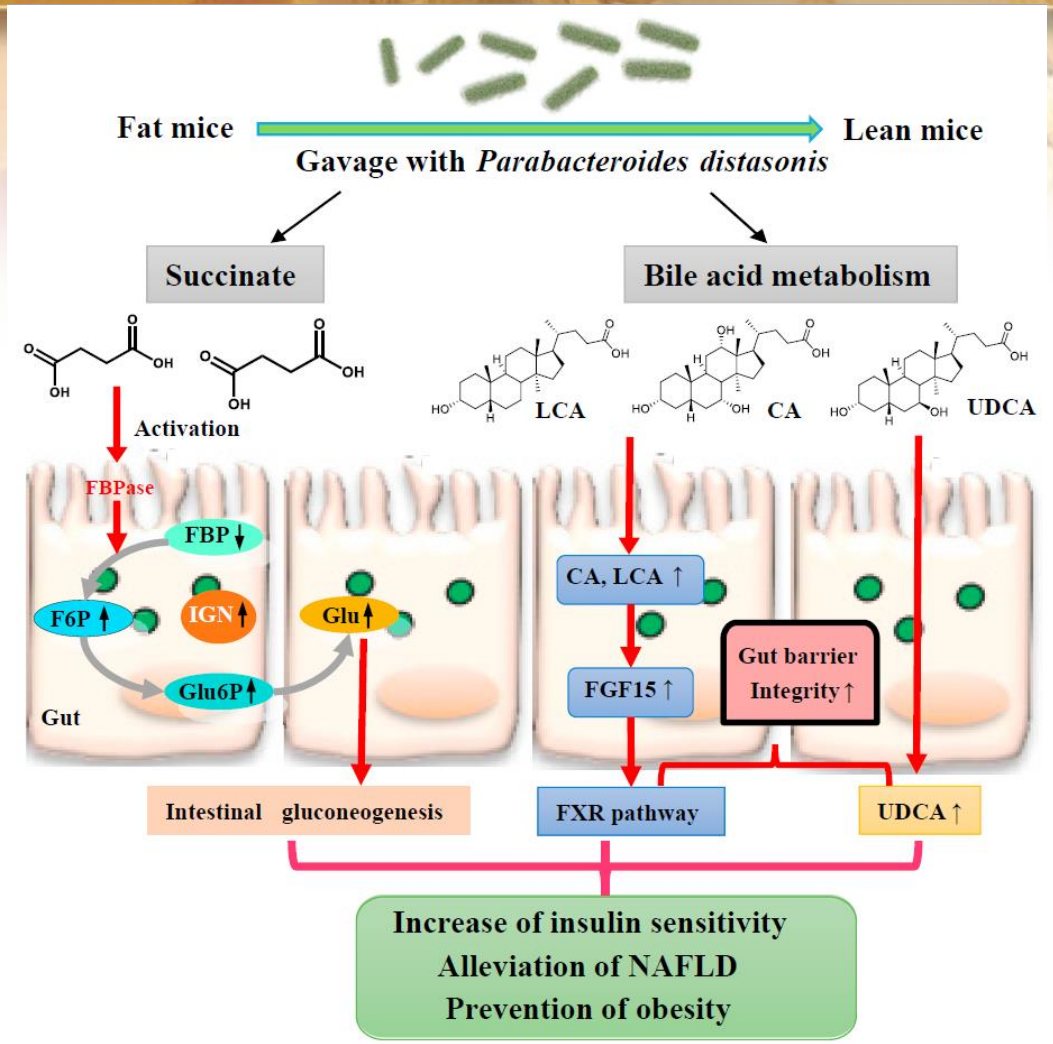
Legend	Taxonomy
	k__Bacteria;p__Actinobacteria
	k__Bacteria;p__Bacteroidetes
	k__Bacteria;p__Cyanobacteria
	k__Bacteria;p__Deferribacteres
	k__Bacteria;p__Firmicutes
	k__Bacteria;p__Proteobacteria
	k__Bacteria;p__TM7
	k__Bacteria;p__Tenericutes
	k__Bacteria;p__Verrucomicrobia

Microbiota taxa composition at the phylum level

Purple potato extracts regulate gut microbiota



Prebiotic effects of purple potato extracts



PPE supplementation promotes the growth of parabacteroides distosonis, resulting in alleviation of obesity and metabolic dysfunction.

Adapted from Wang *et al.* 2019. Cell Reports, 26, 222-235

Conclusion

- Anthocyanins derived from purple potatoes showed promising antioxidant activity and bioaccessibility *in vitro*.
- Supplementation of anthocyanin-rich extracts from purple potatoes prevented high fat-diet and endotoxin induced obesity and reversed inflammatory tone.
- Dietary purple potatoes derived anthocyanins regulate the interplay of metabolites, microbiota and gut sensing ability, leading to maintaining gut barrier functionality and mucosal immune homeostasis.
- Continued effort in breeding highly pigmented potato varieties such as anthocyanin-rich ones will provide additional source of healthy food and feed resource.

Acknowledgment

- Dr. Al Sullivan – University of Guelph
- Dr. Yoshinori Mine - University of Guelph
- Dr. Lili Mats; Honghui Zhu, Dr. Ronghua Liu – GRDC/AAFC
- This project was supported by the AAFC A-base project #J-000991.001.33

Thank you!