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Chinese Oat-Rice Processing and Quality Evaluation

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China Agriculture
Research System
现代农业产业技术体系

Outline

- Introduction of Chinese naked oats and oat-rice
- Quality requirement of oat-rice
- Nutrition value of oat-rice
- Animal test of oat-rice
- Clinique trail results of oat-rice

Covered oats and Naked oats



Easy for crop management
Need dehull machine
Need deactivation before ship
High in beta glucan content
Nice mouth feel
Mainly oat flakes for breakfast

High Yield (6t/ha)
Cultivated in fertilized soil
Main crops

Easy handle
Don't need dehull machine
Easy transportation and processing
High in protein, lipid, mineral
Rich in flavors
More food diversity mainly flour products
Low yield (2-3t/ha)
Dry & Semi-dry region, High latitude region, Poor fertilizer, Sandy soil or alkaline soil, No irrigation
Minor grain crops

Chinese oat foods

80k tons in 2012, mainly in Northwest and North China;

–80% is oat flour products, mostly consumed in kitchen and restaurants

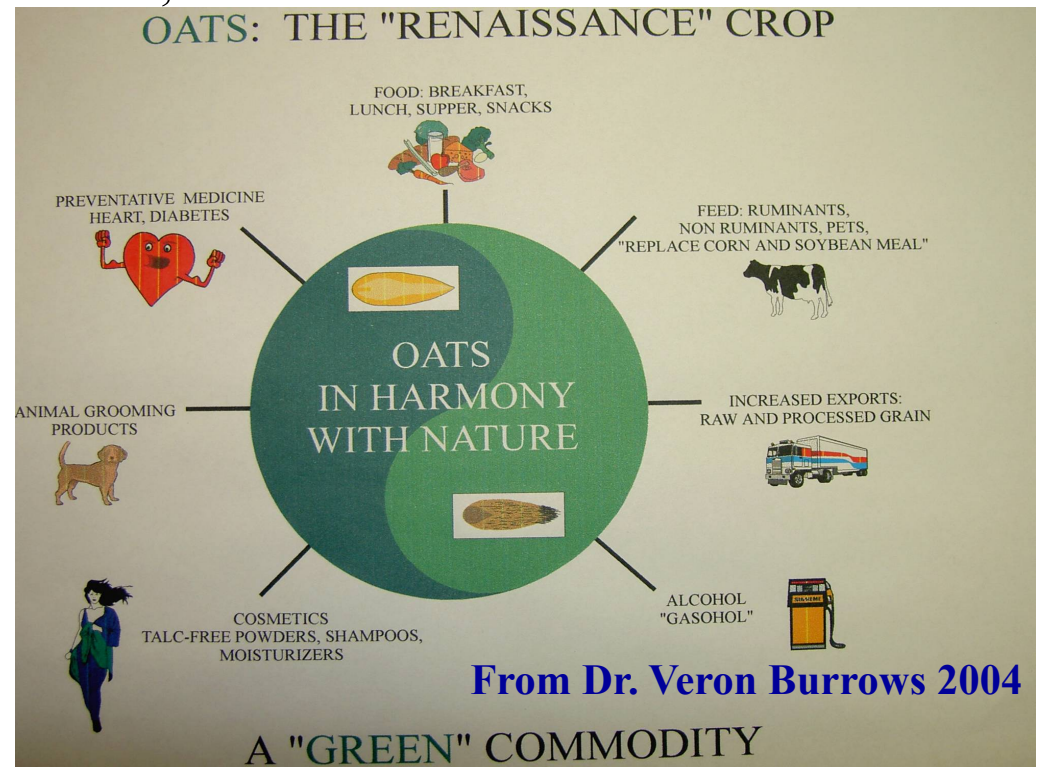
–15% is oat flakes

–5% is oat-rice, beverage, value-added processing



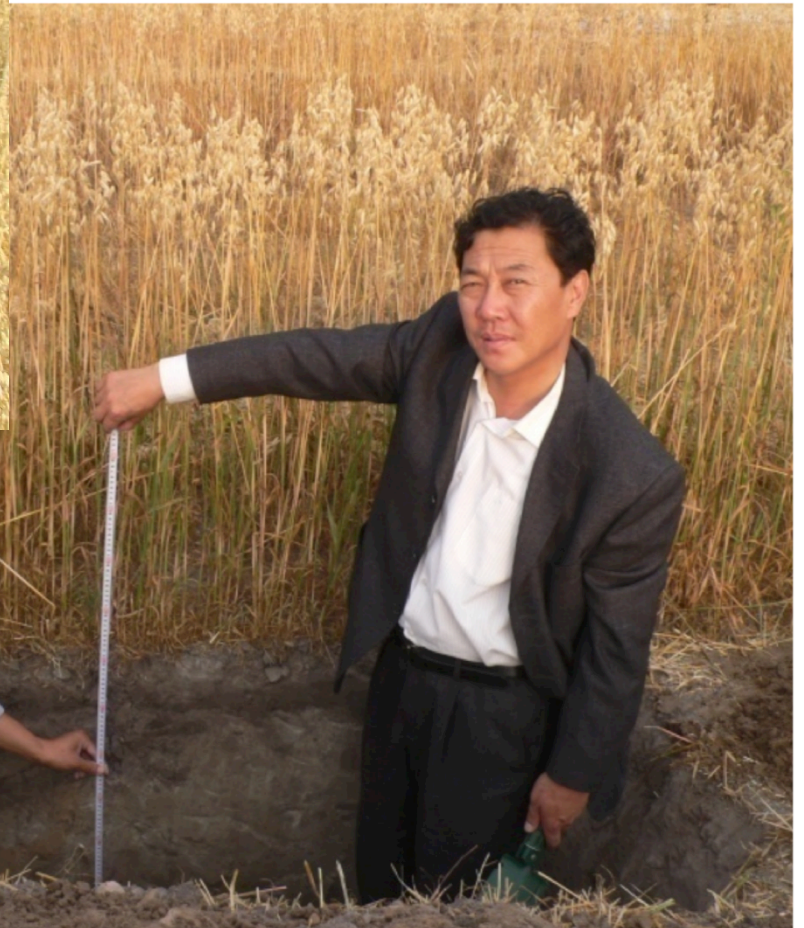
Culture of Chinese naked oats

- Oats make people and horses keep hunger away for a very long time.
 - It is said that Genghis Khan and his troops (AD1162-1227) could ride so far from Baltic Sea to Pacific Ocean, from Siberia to the Persian Gulf, all people ate oat and all horses were fed with oat.
 - Eat oat food can make people walk 30 km, but for wheat based food, the distance is only 20 km, for the corn food, is 10 km.



Naked oats in saline soil

(Root depth 1.97m) (pH 8.5-9.3; yield 2t/ha)



Naked oats grow in sandy soil



Naked oats grow in the mountain region



Introduction of oat-rice and Chinese market

- Oat-rice used naked oats as the raw materials, combined with the abrasive milling, infrared roasting and mixed or not with rice to produce the better mouth-feel oat-rice.
- can be classified into three types according to their processing technology
 - Firstly is the cleaned and selected naked oat kernel
 - Secondly is the debraned, deactivated naked oat
 - Thirdly is the steel-cut, deactivated naked oat
- The disadvantages includes the coarse taste, short shelf life, longer cooking time.



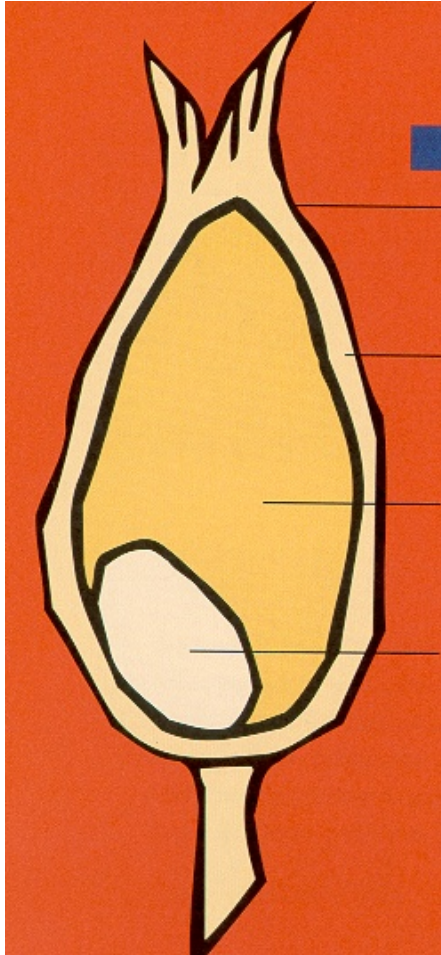
Nutrition value of oat-rice

Oat-rice : rice	Protein (g/100g)	Fat (g/100g)	β -glucan (g/100g)	Ash (g/100g)
0:100	7.10a	0.50a	0.40a	0.27a
10:90	7.50a	0.98a	0.89a	0.38a
20:80	8.02a	1.85b	1.26a	0.53a
30:70	8.87a	2.21b	1.72a	0.63a
40:60	9.00a	3.19 b	2.19a	0.81a
100:0	13.80b	6.51c	4.30b	1.67b

The lipase activity and kernel size

Variety		Single Kernel area (mm)	1000 kernel weight (g)	Area/weight	Lipase activity ($\mu\text{mol/g/h}$)
V1	Large (Selected)	13.84a	28.56a	4.76g	216.7ef
	Small (Selected)	10.44de	18.27efg	5.71cd	249.2d
	Normal kernel	12.10b	23.92bc	5.11f	207.8f
V2	Large (Selected)	11.61bc	22.27cd	5.21ef	67.7h
	Small (Selected)	8.71g	13.67i	6.35a	93.5g
	Normal kernel	9.54f	15.33hi	6.23ab	72.9gh
V3	Large (Selected)	13.80a	24.91b	5.54de	386.7c
	Small (Selected)	11.15cd	17.57fgh	6.35a	523.1a
	Normal kernel	12.02b	20.26de	5.94bc	490.0b
V4	Large (Selected)	12.25b	22.77bc	5.38def	209.7f
	Small (Selected)	9.72f	15.98gh	6.08ab	239.7de
	Normal kernel	10.83d	19.21ef	5.66cd	236.6de

Lipase distribution among the kernel



Debran time /s	Debran ratio / %	whiteness	beta glucan content /%	Lipase activity / $\mu\text{mol/g/h}$
0	0e	77.02c	3.47a	325.8a
5	1.6e	78.72b	3.53a	317.8a
10	3.0de	79.65ab	3.24b	254.0b
15	4.1de	79.53ab	2.90c	257.7b
20	6.5cd	79.88ab	2.91c	216.8c
25	8.6c	79.94ab	2.28f	187.5d
30	10.5bc	80.68a	2.31f	144.3f
35	13.6ab	80.39a	3.02c	169.7e
40	15.1a	80.84a	2.57e	72.4h
45	15.9a	80.80a	2.78d	119.8g

Kernel tempering moisture content and lipase activity of oat-rice

Tempering moisture content (%)	1000 kernel weight (g)	Final Tem. of the oat kernel line (°C)	Lipase activity (μmole/g/h)	Peroxidase activity (Quantity)
16	18.4	83	42.3	+
	23.7	85	16.0	0
18	18.4	88	9.0	0
	23.7	97	1.0	0
20	18.4	104	—	—
	23.7	105	—	—

Different oat variety has different enzyme activity

Variety	1000 Kernel Weight (g)	Final Temp. (°C)	Lipase activity ($\mu\text{mole/g/h}$)	Peroxidase activity (Quantity)
V1	23.7	105	--	--
V2	15.5	90	4	+
V3	20.2	99	14	0
V4	19.3	97	--	0

Standard of mixed rice of oat- rice and rice sensory evaluation

Assessment Item	Bad					Criterion	Good				
	lowest	very	some	A little	little		little	A little	some	very	hiest
	-5	-4	-3	-2	-1	0	1	2	3	4	5
Aroma	No obvious oat aroma						Has the clear oat aroma				
Appearance	Rice color was dark, or popped						Rice color was bright, structure was uniform				
Taste	Not sweetness or special cereal smell during chewing						sweetness or special cereal smell during chewing				
Viscosity and Elasticity	Stick or no elasticity						Smooth, chewingness, no-stick				
Hardness and softness	Over hardness or over softness						medium				
Overview	According to the reviewer's feeling, priority and compared with the criterion sample, summarized all the value										

Sensory evaluation result of different proportional mixed rice

Oat-rice : rice	10:90	20:80	30:70	40:60	100:0
Aroma	2.00 bc	3.17 a	2.33 ab	1.00 c	1.67 bc
Appearance	1.33 bc	3.50 a	2.33 ab	0.33 c	0.67 c
Taste	2.50 bc	3.83 a	2.67 b	1.67 c	-2.33 d
Viscosity and Elasticity	0.50 a	1.17 a	0.67 a	-0.80 b	-2.33 c
Hardness and softness	0.67 b	1.67 a	1.50 a	-0.83 c	-2.17 d
Synthetically evaluation	7.0	13.34	9.5	1.37	-4.49

Quality and nutrition components of the oat-rice products in Chinese market

Indices	Saibao	Zhangjiakou	Jiamai	PepsiCo Quaker
Protein content(%)	14.4	14.11	14.55	10.84
beta-glucan(%)	4.44	4.72	4.85	3.96
lipids(%)	7.61	6.39	7.81	6.74
Saturated lipids(%)	19.68	19.63	18.59	18.05
Unsaturated lipids(%)	78.01	79.11	78.39	78.34
Ca(mg/kg)	275.3	508.5	269.6	2427.0
Fe(mg/kg)	64.4	53.0	69.3	45.6
Zn(mg/kg)	31.0	24.5	31.8	16.5
K(mg/kg)	3181.7	3666.8	3071.7	3390.7
Na(mg/kg)	104.6	126.8	102.5	193.3
Mg(mg/kg)	1235.0	1049.5	1140.0	873.4

oat-rice processing critical control point

- ❑ Kernel size screening: 1000 kernel weight higher than 23g, kernel has short length, light, less trichome.
- ❑ Debran treatment with abrasive mill (debraning ratio is around 3%): remove the trichome, broken the surface, let the moisture and heat transfer into the kernel.
- ❑ Lipase activity: need the steaming treatment, or during the kilning stage need moisture tempering and last enough time.
- ❑ Mix with rice: to improve the mouth-feel, can be mixed with rice with around 30%.



Kernel size effects the oat-rice processing yield and sensory evaluation value

	Small kernel	Medium kernel	Large kernel	Original kernel
length	6.64	6.80	7.37	7.35
width	2.20	2.61	2.64	2.52
thickness	1.76	2.11	2.32	2.11
Test weight	687.9	754.7	750.4	725.4
1000 kernel weight	19.8	28.0	32.5	27.6
whiteness	82.0	84.7	85.1	85.9
moisture	10.4	11.0	11.3	10.4
Debran ratio	7.5	3.1	3.9	2.4
Production yield	92.0	97.3	97.2	98.0

	Small kernel	Medium kernel	Large kernel	Original kernel
aroma	1.5	3.0	1.25	0.5
appearance	-1.25	3.0	2.25	1.0
taste	0.5	1.0	0.75	1.5
Stickiness and springness	0.5	2.0	3.0	2.25
softness	0	2.0	-0.25	3.25
General evaluation	0.75	11.0	8.0	8.5



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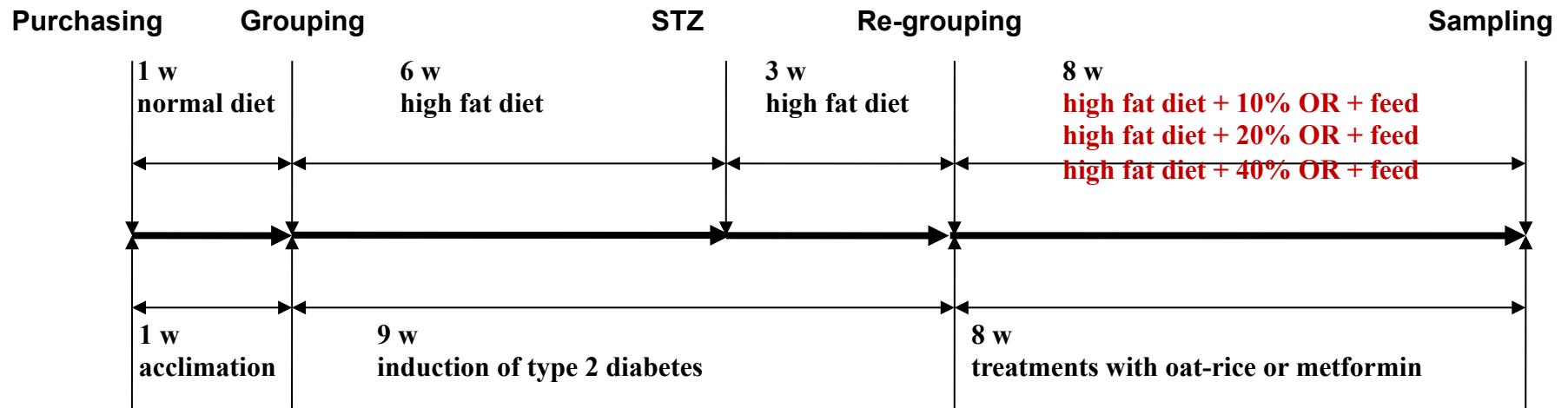


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Animal test of oat-rice



Animal feed ingredient and energy

	Control	High Fat	Low Oat-rice	Medium Oat-rice	High Oat-rice
<i>Ingredient</i>	g/100g air-dried diet				
Oat-rice	0.0	0.0	10.0	20.0	40.0
Corn starch	56.00	40.57	31.57	23.57	5.57
Wheat flour	10.00	7.78	7.78	7.78	7.78
Fish meal	26.00	20.23	20.23	20.23	20.23
Soybean oil	2.00	1.56	1.56	1.56	1.56
Bone meal	3.00	2.33	2.33	2.33	2.33
Yeast extract	2.30	1.79	1.79	1.79	1.79
Salt	0.50	1.39	1.39	1.39	1.39
Vitamin-mineral premix	0.20	0.16	0.16	0.16	0.16
Lard	0.00	13.00	12.00	10.00	8.00
Egg yolk meal	0.00	10.00	10.00	10.00	10.00
Cholesterol	0.00	1.00	1.00	1.00	1.00
Cholate	0.00	0.20	0.20	0.20	0.20
Net energy kcal/100g air-dried diet	419.91b	459.91a	452.92a	457.52a	454.78a

The influence on mice's blood lipid

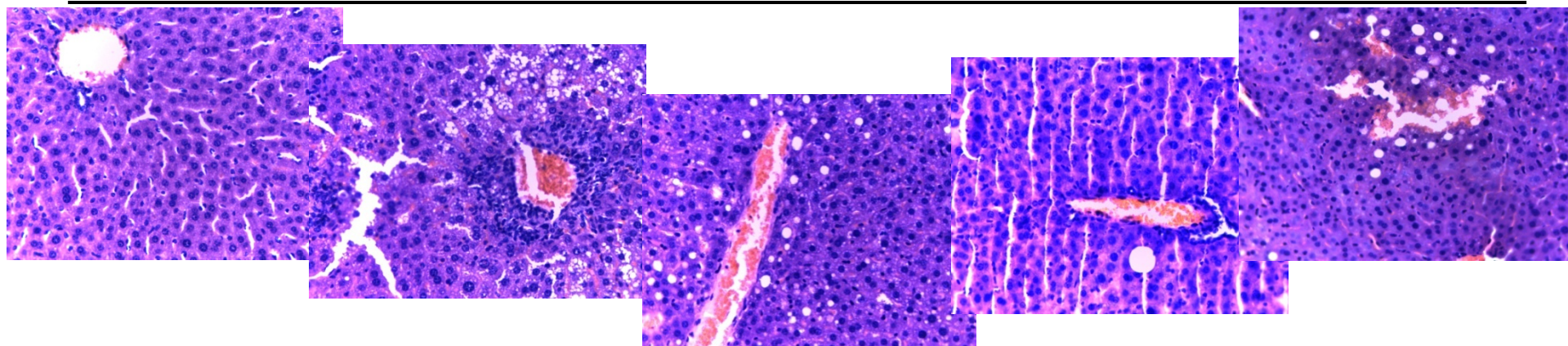
Diet group	TG (mmol/l)	TC (mmol/l)	HDL-C (mmol/l)	LDL-C (mmol/l)
Control	0.89 ± 0.03c	3.05 ± 0.20b	2.76 ± 0.07b	1.65 ± 0.11c
High Fat	1.06 ± 0.12a	2.88 ± 0.08c	2.87 ± 0.06b	1.54 ± 0.04d
Low Oat-rice	0.88 ± 0.04c	3.36 ± 0.13a	3.10 ± 0.14a	1.84 ± 0.07a
Medium Oat-rice	0.95 ± 0.08bc	3.09 ± 0.07b	3.09 ± 0.07a	1.70 ± 0.04bc
High Oat-rice	0.99 ± 0.07ab	3.14 ± 0.07b	3.15 ± 0.08a	1.72 ± 0.04b

The influence on mice's FPG, FINS, IAI and IR

Diet group	FPG(mmol/L)	FINS ($\mu\text{g/L}$)	IAI	IR
Control	2.41 \pm 0.20c	0.81 \pm 0.10b	-0.67 \pm 0.15a	-2.44 \pm 0.08c
High Fat	3.26\pm0.41b	1.07\pm0.30a	-1.25\pm0.35b	-1.87\pm0.12a
Low Oat-rice	4.17 \pm 0.47a	0.86 \pm 0.14b	-1.28 \pm 0.30b	-1.83 \pm 0.13a
Medium Oat-rice	3.35\pm0.37b	0.83\pm0.18b	-1.02\pm0.27b	-2.09\pm0.16b
High Oat-rice	3.31 \pm 0.42b	0.87 \pm 0.10b	-1.05 \pm 0.26b	-2.06 \pm 0.05b

The influence on mice's Fat coefficient, TG and Liver coefficient

Diet group	Fat coefficient (%)	Liver TG (nmol/l)	Liver coefficient (%)
Control	2.84±0.41b	284.04 ±41.51c	3.85±0.06cd
High Fat	3.76±0.52a	390.55±46.07a	4.52±0.15a
Low Oat-rice	2.59±0.29b	271.82±35.65c	3.95±0.07b
Medium Oat-rice	2.61±0.27b	296.25 ±42.89c	3.77 ±0.07d
High Oat-rice	2.90±0.34b	338.85 ±25.56b	3.87 ±0.11bc



Clinique trail results of oat-rice (1)

- 56 volunteers, eat oat-rice 8 weeks, 50g per-day for each person.
- TG reduced 15.70% ($P < 0.01$) $n=52$;
- TC reduced 13.5% ($P < 0.01$) $n=47$;
- HDL-C increased 11.2% ($P < 0.01$) $n=46$;
- LDL-C reduced, but no significantly, $n=22$;
- Body weight reduced, but no significantly, $n=56$;
- Clinique trail results showed: The oat-rice has the effects of cholesterol reducing ability.

2、燕麦米辅助降血脂临床观察结果：收集本院接治高血脂患者56例，自愿服食燕麦米，每日50克。服食8周后，52例患者的TG有不同程度降低，平均降低0.42mmol / L，TG降幅15.70%，达到极显著水平 ($P < 0.01$)；47例患者的TC有不同程度降低，平均降低0.68mmol / L，TC降幅13.5%，达到显著水平 ($P < 0.05$)；46例患者的HDL-C有不同程度的增高，平均增高0.06 mmol / L，增幅11.2%，达到显著水平 ($P < 0.01$)；22例患者的LDL-C有不同程度降低，但未达显著水平 ($P > 0.05$)。8周后观察对象体重平均下降0.66公斤，但未达到显著水平。患者食用燕麦米均无不良症状。临床观察结果说明燕麦米具有明显的辅助降血脂作用。

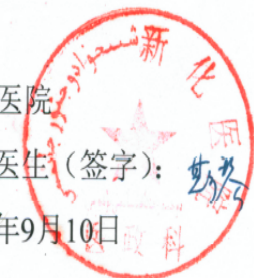
备注：燕麦片及燕麦米提供单位为吉林省白城农业科学院

燕麦原料品种为白燕2号

新化医院

责任医生(签字):

2012年9月10日

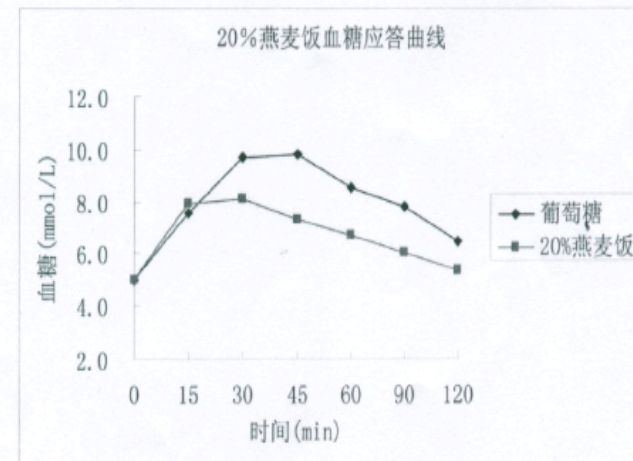


Glucose Index of 20% and 35% oat-rice with rice tested by Clinique trail in Shanghai

- Glucose used as control, GI is 100
- 20% oat rice mixed with rice, GI is 56.5
- 30% oat rice mixed with rice, GI is 56.1
- The results showed the mixture oat-rice has the low GI, can reduce the fast blooding

50克葡萄糖和25%燕麦米饭餐后平均血糖值 (mmol/L)

	0分	15分	30分	45分	60分	90分	120分
50g 葡萄糖	4.98	7.56	9.69	9.81	8.51	7.77	6.45
20%燕麦米饭	4.99	7.90	8.10	7.29	6.70	6.00	5.34



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Summary

- ❑ Oat-rice nutritional value is higher than rice.
- ❑ The critical control point of oat-rice is
 - ❑ kernel size screening (20-25g/thousand kernel weights),
 - ❑ debran with abrasive mill,
 - ❑ steaming treatment and infrared roasting.
- ❑ The lipase activity and peroxidase activity were deactivated. The final oat-rice has the lighter color, delight taste, shorter cooking time, longer shelf life, balanced amino acid value and can be cooked together with the rice at the same time.
- ❑ Medium oat-rice (20%) group and high oat-rice group, the mice's weight, TG, fat coefficient and liver coefficient were lowest; HDL-C and insulin were highest; hepatic steatosis was mostly controlled by feeding medium oat-rice feed.

Thank you for your attention!

Thanks for the team and financial support from CARS-08-D

