Relationship between Lipase Activity and Oats Kernel Physical Characters

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Introduction

Naked oats are the preferred oats in China for food applications but there are still very limited choices of products. Developing new oat based foods for the Chinese market is a research objective at Northwest A&F University.

The oat enzyme plays an important role in oat food storage and processing, but it has the bad effect on shortening food storage time and arising free fatty acid oxidation. Deactivation treatment is necessary for prolonging shelf life and increasing value.

It studies the influence of oat kernel size, genetic difference, and debran treatment on lipase activity in order to provide the fundamental comments for oat breeding and food processing. It had an important contribution for understanding the distribution law of lipase, restraining lipase activity, improving mouth feel of oat food, and developing Chinese style oat staple food.

The object of the research is:

1) Effects of oat kernel size and other physical characteristics to enzyme activity;
2) Lipase distribution in the kernel.

Materials & Methods

Naked oats were harvested from the crop year of 2005. The VAO-2 naked oats came from a 15 acres field grown in Ottawa (Ontario, Canada), while the other three lines (VAO-3, VAO-10, and VAO-22) were grown in large seed plots at Indian Head (Saskatoon, Canada). After the kernels were harvested, they were cleaned and dehulled. Small kernels were obtained with a dockage tester according to the size (5/64×3/4, the upper is larger kernel, the groats passed through the sieve is smaller kernels), and then put in -20℃ cool room.

Sample Preparation

Kernel size distribution: 200 random oat kernels (4 batches ×50) were used to scan the kernel shape and size the Regent SEEDLE (Regent instrument Inc., Quebec Canada). The indices were including area (mm2), width (mm), length (mm), and ratio (width/length).

Kernel b-glucan examination by Florence microscopy.

Oat pearling were used`TM-05C Satake Mill (Satake Corporation, Japan) by the methods of Dr Zhou and Dr Burrows.

Analysis

Lipase activity determination: it was according to the methods from Urquhart et al (1983), Kwon et al (1986), and Peterson (1999).

The data analysis used Gene and Gene Environment Interaction Biplot (or GGEbiplot) software by Weikai Yan (2002).

Results and Analysis

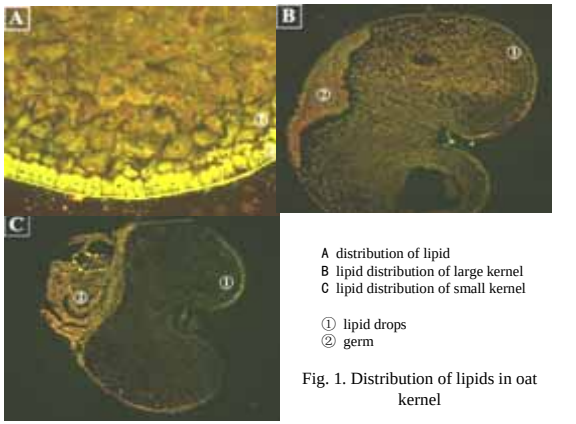
Table I Kernel size, lipase activity and other physical character of oat samples

varities	Area /mm2	length /mm	Width/ mm	1000 kernel weight/(g)	Area/ Weight (mm2/g)	Lipase activity Umol/g/h	Lipid content/%
VAO-2 LK	13.84a	7.24a	2.38bc	28.56a	4.76g	216.7ef	5.69h
VAO-2 SK	10.44de	6.32cd	2.05f	18.27efg	5.71cd	249.2d	5.86h
VAO-2NK	12.10b	6.78b	2.24cde	23.92bc	5.11f	207.8f	5.40h
VAO-3 LK	11.61bc	5.92e	2.56a	22.27cd	5.21ef	67.7h	8.29c
VAO-3 SK	8.71g	5.16g	2.18e	13.67i	6.35a	93.5g	9.77a
VAO-3NK	9.54f	5.34fg	2.30cd	15.33hi	6.23ab	72.9gh	9.32b
VAO-10 LK	13.80a	7.06a	2.50ab	24.91b	5.54de	386.7c	7.77de
VAO-10 SK	11.15cd	6.44c	2.22de	17.57fgh	6.35a	523.1a	8.54c
VAO-10NK	12.02b	6.62b	2.30cde	20.26de	5.94bc	490.0b	8.15cd
VAO-22 LK	12.25b	6.20d	2.56a	22.77bc	5.38def	209.7f	6.73g
VAO-22SK	9.72f	5.50f	2.28cde	15.98gh	6.08ab	239.7de	7.61ef
VAO-22NK	10.83d	5.84e	2.38bc	19.21ef	5.66cd	236.6de	7.29f

Note: Means within a column followed by different letter(s) are significantly difference at p=0.01.
LK-Large kernel after sieved; SK-Small kernel after sieved; NK-Normal kernel

Table II Lipase activity and physical character of debraned oat rice

Satake time/s	Debran ratio/%	Area /mm2	Width/ mm	1000 kernel weight/(g)	Area/Weig (mm2/g)	Lipase activity Umol/g/h	Lipid content/%
0	0e	11.21a	6.62a	21.34a	11.30a	325.8a	6.53d
5	1.6e	11.48a	6.46ab	21.40a	10.73ab	317.8a	6.69c
10	3.0de	11.20a	6.34abc	20.89ab	10.73ab	254.0b	6.78c
15	4.1de	11.32a	6.34abc	21.26ab	10.65ab	257.7b	6.81bc
20	6.5cd	10.80ab	6.24bc	20.37ab	11.17ab	216.8c	7.06a
25	8.6c	11.01ab	6.34abc	20.47ab	10.76ab	187.5b	6.86bc
30	10.5bc	10.67ab	6.20bc	20.36ab	10.48b	144.3f	6.87bc
35	13.6ab	10.97ab	6.30abc	20.58ab	10.43b	169.7e	6.85bc
40	15.1a	10.25b	6.07c	19.13b	10.73ab	72.4h	6.96ab
45	15.9a	10.5ab	6.18bc	19.12b	11.05ab	119.8g	6.79bc



A distribution of lipid
B lipid distribution of large kernel
C lipid distribution of small kernel

① lipid drops
② germ

Fig. 1. Distribution of lipids in oat kernel

Table 1

- The lipase activity negatively correlated with the kernel size, area, width; and the thousand kernel weight positively correlated with the area-weight ratio.
- lipase activity is positively associated with the lipid content in oats.

Table 2

- The lipase activity decreased with the peeling time prolonged, it showed that the lipase or its carrier was mainly distributed in the cortex and aleurone layers. The more the outlayer wiped off, the lower the lipase activity of the kernel.

Figure 1-A,1-B,1-C

- Large kernels exhibited smaller specific surface area and low lipase activity. varieties with a size much smaller such as VAO-3 had relatively higher enzyme activity
- Except for the germ, the fat content is much higher in the cortical layer Fat content is lower in big granules while it is higher in small granules.

Figure 2

- It shows that the lipid activity negatively correlated with the peeling time, peeling ratio and lipid content (r2= -0.959***,-0.910***,-0.650*） and further demonstrate the location relationship between the lipase activity and cortex.

Conclusion

Analyzing the lipase activity using all kinds of size of different oat varieties and the change of the lipase activity after peeling. Hence, larger kernels will be best for processing because of the ease in handling and also the enzyme activity is much lower and easy to control.

Lipase and its carrier are mainly distributed in the cortex and aleurone layer;
The lipase activity has a significantly negative correlation with the peeling time, peeling ratio, which led to choose the 20s debran as the best technology for oat rice development.
Since lipase is mainly distributed in the out layer of the kernel, it is necessary to select a reasonable, economical, and speedy deactivation method during the process of the oat enzyme-inactivation in order to acquire triplicate effects: the better taste, sustainable nutrition and reduced enzyme activity.

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