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Study on Rapid Detection of Degree of Freshness of Paddy Rice in China

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Abstract

This paper describes research results and progress of rapid detection of the degree of freshness of paddy. We studied the changes of degree of freshness, fat acidity value and taste evaluated value of paddy under different storage conditions in the laboratory. The correlations between the degree of freshness, fat acidity value and taste evaluated value were analyzed. The results showed that there was a significant negative correlation ($p < 0.01$) between the degree of freshnessand fat acidity value. The correlation coefficient was -0.845. The degree of freshness was significantly positively correlated with the taste evaluated value, and most of the correlation coefficients were above 0.9. The nationwide investigation result of paddy's degree of freshness showed that there was an obvious distinction in the degree of freshness between newly harvested rice and rice harvested in previous years. The degree of distinction of indica rice achieved 85%. Due to its special reasons, japonica rice had a lower degree of distinction, but it also reached 75%.

Keywords: paddy, degree of freshness, fat acidity value, taste evaluated value.

1. Introduction

Rice is a staple food for more than 60% of the world's population, especially in China (Wei et al., 2007). As a primary dietary source of carbohydrates, rice plays an important role in meeting caloric requirements and nutrient intakes (Yang et al., 2006). Aging during storage results in numerous changes in the chemical and physical properties of rice (Patindol et al., 2005; Singh et al., 2006; Sodhi et al., 2003). These changes in pasting properties, color, flavor, and composition affect rice cooking and eating quality (Srikaeo K et al., 2013; Park C E et al., 2012). The fresh rice is prefered in the market in China. So it is particularly important to detect the degree of freshness rapidly during acquisitions, and during daily or long-term storage of paddy rice.

Since 2013, we have developed an instrument which could detect the paddy freshness rapidly for the degree of freshness. The higher the degree of freshness of paddy is, the fresher it is. The detection principle of the degree of freshness of paddy is that milled rice is mixed with special reagent, according to the different contents of ketones and aldehydes, the solution reveals different color. Analysing the spectrum of these colors, we can quantify the degree of freshness of paddy. The instrument is easy to use, and the results are objective and accurate.

In nearly two years, the research on rapid detection of degree of freshness has made new progress. We studied the changes of paddy freshness qualities during different conditions of storage in a

laboratory and the correlations between the degree of freshness, taste evaluated value, and fat acidity value. The result proved that the degree of freshness is a sensitive index which can reflect its freshness quality in the aging process. We have detected the degree of freshness of paddy rice of different producing areas, varieties and production years for three years across the country. A total of 9381 samples were statistically analyzed, yielding the standard of determination and evaluation of degree of freshness of paddy.

2. Materials

2.1 Materials of Storage Experiment

Fourteen samples of fresh japonica rice and indica rice were selected from 6 provinces which included Jiangsu, Heilongjiang, Jilin, Jiangxi, Zhejiang and Anhui. The japonica rice samples were numbered from 1 to 9, and the indica rice were numbered 10 to 14.

2.2 Nationwide investigation of paddy degree of freshness

The producing area of indica rice samples covered 14 provinces and the harvest years were from 2012 to 2016. The number of samples of indica rice was 3106. There were 2097 new havest samples in 2015 and 2016, and 1032 samples harvested in previous years from 2011 to 2014.

The producing area of japonica rice covered 6 provinces and the harvest years were from 2011 to 2016. The number of samples of japonica rice was 1612. There were 1177 new havest samples in 2015 and 2016, and 357 samples harvested in previous years from 2011 to 2014.

3. Instruments and Equipment

Degree of freshness tester of paddy rice: JCXD10, Beijing Dongfu Jiuheng Instrument Technology Co., Ltd.

Rice hulling machine: JDMZ, Beijing Dongfu Jiuheng Instrument Technology Co., Ltd.

Rice mill: JNM - Ⅲ, Chengdu Shitewei Technical and Development Company.

Hammer Cyclone mill: JXFM110, Shanghai Jiading Grain and Oil Instrument Co., Ltd.

4. Experimental Method

4.1 Grain storage and sampling method

After packing and sealing, experimental paddy samples were stored at indoor constant temperatures of 25℃ and 35℃, respectively. Three hundred and fifty grams of paddy were sampled periodically and the specific sampling times are shown in Tab. 1.

Tab. 1 Sampling Time.

Sampling Frequency	Sampling Time	
	25℃/(W)	35℃/(W)
start	0	0
first	8	2
second	20	4
third	60	7
fourth	92	12
fifth		24
sixth		32
seventh		64

W: means per week

4.2 Degree of freshness determination

In accordance with LS/T 6118-2017 Inspection of grain and oils-Determination and evaluation of degree of freshness of paddy.

4.3 Fat acidity value determination

According to the appendix A of *GB/T 20569-2006 The determination rules of rice quality in storage.*

4.4 Taste evaluated value determination

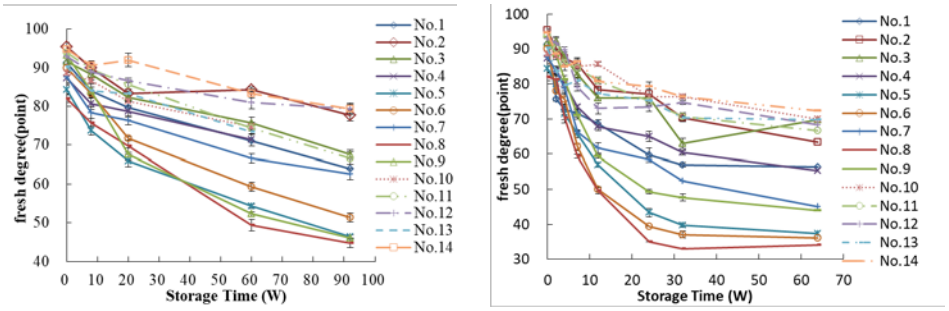
According to the appendix B of *GB/T 20569-2006 The determination rules of rice quality in storage*.

5. Results and Analysis

5.1 Results of storage experiment

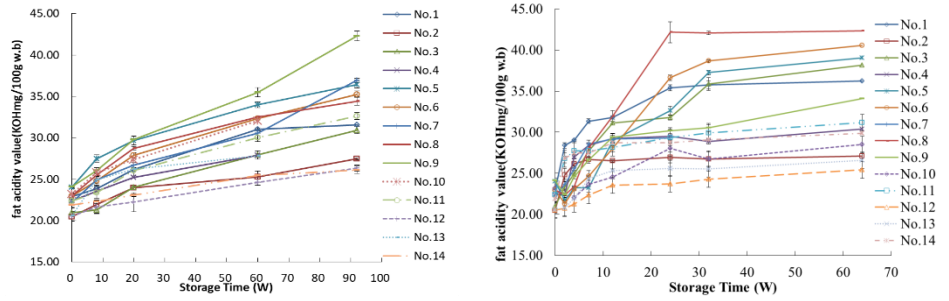
5.1.1 Change of each quality indicators

The change in degree of freshness, fat acidity value and taste evaluated value in fourteen paddy samples stored respectively under 25℃ and 35℃ constant temperature conditionsare as shown in Figs. 1, 2 and 3 over lngth of storage time.



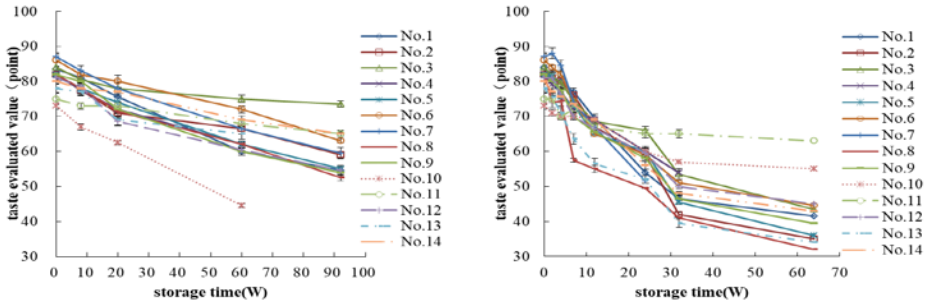
a 25℃ b 35℃

Fig. 1 Change in degree of freshness during storage time.



a 25℃ b 35℃

Fig. 2 Changein fat acidity value during storage time.



a 25℃ b 35℃

Fig. 3 Change in taste evaluated value during storage time.

These figures show that paddy degree of freshness and taste evaluated value decreased over storage time, while fat acidity value increased. Thus, these three indicators can accurately reflect the degree of deterioration of paddy's quality during time in storage.

5.1.2 Correlation between degree of freshness and fat acidity value

The density ellipse of degree of freshness and fat acidity value of storage samples at a confidence level of p = 0.95 is shown in Fig. 4.

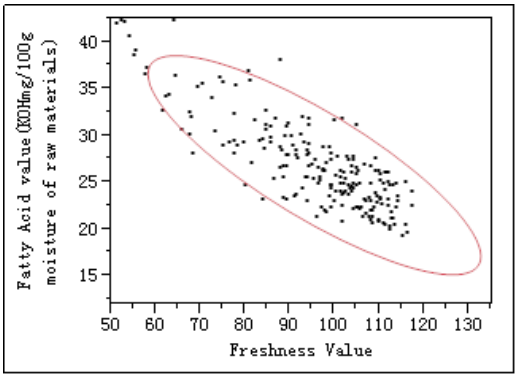


Fig. 4 Correlation of the degree of freshness and fat acidity value of storage samples at a confidence level of p=0.95.

The correlation and significance test of degree of freshness and fat acidity value of storage samples are shown in Tab. 2.

Tab. 2 Correlation and significance test of the degree of freshness and fat acidity value of storage samples.

variable	mean value	standard deviation	correlation r	significance probability p	quantity
Degree of freshness	91.22	14.78	-0.845	＜.0001*	162
Fatty acids value	27.68	4.96			

The correlation coefficient of degree of freshness and fat acidity value was -0.845, and the significant probability was smaller than 0.0001. These values suggest that the degree of freshness of paddy is significantly negatively correlated with its fat acidity value.

5.1.3 Correlation between degree of freshness and taste evaluated value

Due to the great influence of paddy varieties on the taste evaluated value, the correlation analysis between the degree of freshness and the taste evaluated value was carried out separately for each sample. The results are shown in Tab. 3 and Tab. 4.

Tab. 3 Relationship between degree of freshness and taste evaluated value of paddy stored at 25 °C.

Number	Indicator	Storage time (w)					Correlation coefficient
		0	8	20	60	92	
1	TAV	84	81	76	60	55	0.98
	FD	91	84	80	71	64	
2	TAV	82	78	71	67	59	0.97
	FD	95	90	83	84	78	
3	TAV	84	81	78	75	74	0.97
	FD	92	88	82	76	68	
4	TAV	82	78	72	62		0.98
	FD	87	81	79	71		
5	TAV	82	78	74	62	55	0.98
	FD	84	74	66	54	46	
6	TAV	86	82	80	72	63	0.96
	FD	90	83	72	59	51	
7	TAV	87	83	78	67	60	0.97
	FD	88	78	76	67	63	
8	TAV	82	78	72	62	53	0.98
	FD	82	76	70	49	45	
9	TAV	82	80	72	60	54	0.98
	FD	93	84	68	52	46	
10	TAV	73	67	63	45		0.98
	FD	89	87	81	75		
11	TAV	75	73	73	68	65	0.99
	FD	94	90	86	74	67	
12	TAV	81	79	69	61	55	0.98
	FD	93	89	87	81	79	
13	TAV	78	77	69	65		0.87
	FD	90	84	83	73		
14	TAV	80	78	77	69	65	0.99
	FD	95	91	92	83	79	

Tab. 4 Relationship between degree of freshness and taste evaluated value of paddy stored at 35 °C.

Number	Indicator	Storage time (w)								Correlation coefficient
		0	2	4	7	12	24	32	64	
1	TAV	84	80	80	77	70	54	47	42	0.90
	FD	91	76	73	72	69	60	57	56	
2	TAV	82	81	80	76	67	59	42	35	0.97
	FD	95	90	87	86	78	77	70	63	
3	TAV	84	82	80	75	69	66	54	44	0.92
	FD	92	92	88	83	76	76	63	70	
4	TAV	82	79	77	72	69	60	54		0.97
	FD	87	84	80	73	68	65	60		
5	TAV	82	82	76	73	65	60	46	36	0.94
	FD	84	80	71	66	57	43	40	37	
6	TAV	86	84	82	75	65	59	51	45	0.96
	FD	90	78	76	62	50	39	37	36	
7	TAV	87	88	85	74	67	52			0.93
	FD	88	84	79	66	62	58			
8	TAV	82	74	75	58	55	50	41	32	0.95
	FD	82	81	70	59	50	35	33	34	
9	TAV	82	80	78	70	66	58	47	40	0.95
	FD	93	88	81	71	59	49	48	44	
10	TAV	73	71	70	70	69	60	57	55	0.98
	FD	89	88	86	85	86	76	76	70	
11	TAV	75	75	70	72	67	65	65	63	0.96
	FD	94	90	86	85	81	75	71	67	
12	TAV	81	81	76	70	67	60	50	45	0.90
	FD	93	92	90	79	73	73	75	68	
13	TAV	78	76	71	64	57	52	40	34	0.95
	FD	90	84	80	81	77	75	70	70	
14	TAV	80	77	76	74	69	56	48	43	0.93
	FD	95	89	85	86	81	79	76	72	

Note: TAV means taste evaluated value. FD means degree of freshness

These experiments were terminated once insects and mould appeared in individual samples during the later period of storage.

The data in Tabs. 3 and 4 show that the degree of freshness of paddy was positively correlated with the taste evaluated value, and most of the correlation coefficients were above 0.9

5.2 Results of nationwide investigation of paddy degree of freshness

5.2.1 Analysis and results of indica rice

The results of degree of freshness of 3106 indica rice samples were analysed, and the distribution of degree of freshnesss of the samples is shown in Fig. 5.

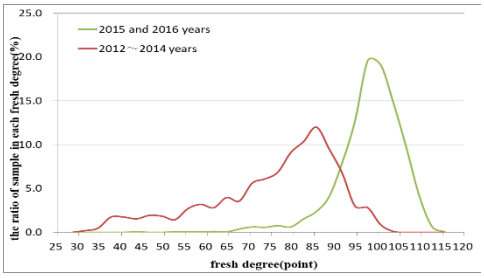


Fig. 5 Distribution of the degree of freshness of indica rice samples.

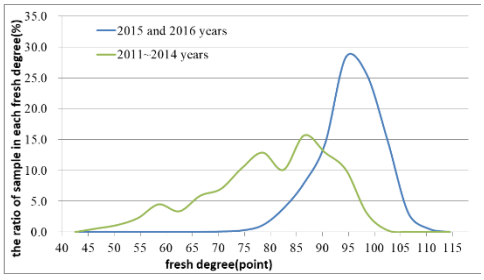


Fig. 6 Distribution of degree of freshness of japonica rice samples.

As shown above, there was an obvious distinction of degree of freshness between new harvest rice and rice harvested in previous years. With data analysis, the discrimination of new harvest samples in 2015 and 2016 and the rice harvested in previous years was close to 85%, ranging from 89 to 90 points.

5.2.2 Analysis and results of japonica rice

The distribution of the degree of freshnesss of 1612 japonica rice samples is shown in Fig. 6.

The results of statistical analysis showed that the discrimination of the degree of freshness of new harvest samples in 2015 and 2016 years and the samples harvested in previous years was close to 76%.

The discrimination of japonica rice was lower than that of indica rice, mainly because of good storage conditions of low temperature and humidity in its production area. Meanwhile the samples of japonica rice with good quality was larger than indica rice during the previous year's production.

Discussion

Above all, the degree of freshness is a rapid detection indicator that can accurately reflect changes of quality of paddy (fresh or not) and has significant correlations with fat acidity value and taste evaluated value. There was a significant negative correlation ($p < 0.01$) between degree of freshness and fat acidity value with a correlation coefficient of -0.845. However, degree of freshness was significantly positively correlated with taste evaluated value. The correlation coefficient was above 0.9.

According to the results of **a** nationwide investigation, there was an obvious distinction between degree of freshness of new harvest indica rice and indica rice harvested in previous years. The degree of distinction achieved 85%. For pecial reasons, japonica rice had a lower degree of distinction, but it also reached over 75%, which conforms to preserving quality according to China's legale storage requirements.

The above results show that the rapid detection technology of paddy's degree of freshness has great applicability to distinguish fresh and non-fresh paddy in China.

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Fumigation with Ph3 using automatic generation - Presentation of results of recent trials

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Abstract

Fumigation is essential part of preservation of grains, other edible commodity and perishables. Phosphine is most commonly used fumigant since more than 65 years. It is now practically the only fumigant and most commonly used. While fumigating with conventional metal phosphide formulations most common problems or concerns are operator safety, laborious to apply, gas retention in structure, uniformity of gas concentration in the structure, solid residues left in the commodity, limitations in ambient conditions to apply the fumigant and others. Bad fumigation practices lead to failed fumigations. These are blamed on insect resistance. Scientists have noted higher tolerance levels, but not resistance to phosphine. To address all the concerns referred, and limitations of conventional fumigants, we have developed a Phosphine generator and a suitable formulation for use with the same. This is a fully automatic machine. The formulation is granular and dust free. Those using our generators have stopped using conventional formulations of phosphine. The paper presents merits of technology, results of trials in various locations and on different commodity. This is the only system, which ensures uniform distribution of gas in entire structure to give 100 % guaranteed fumigation results.

Browning Mechanism and Process Optimization during MaizeMaize KX7349 Drying

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Abstract

Browning of KX7349 maize during drying occurred mainly in the pericarp layer. Browning was caused by oxidation of water soluble matter in the pericarp layer. Moisture content had no significant influence on browning rate. Drying temperature, drying time and drying method (vacuum drying or hot-air drying) had significant influence on the browning rate. Through lab research, a prediction model for the relationship between browning rate and drying air temperature was developed. Total drying time is $y=-13.086+0.289X_1+1.045X_2$, where y is the browning rate（%）, X_1 is drying temperature（℃）, X_2 is total drying time（h）, the value range of X_1 was 30～80, the value range of X_2 was 2～10. The concurrent and counter current dryer was applied in Nenjiang to optimize the drying process. The hot air temperature in each drying stage was reduced. When the hot air temperature of the 1st, 2nd, 3rd drying stage was reduced to 95℃,75℃,60℃