Online training on rice post-harvest management

# Good Practice of Rice Processing for Better Quality
# 稻谷加工工艺实践与质量提升


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# Catalogue

河南工業大學
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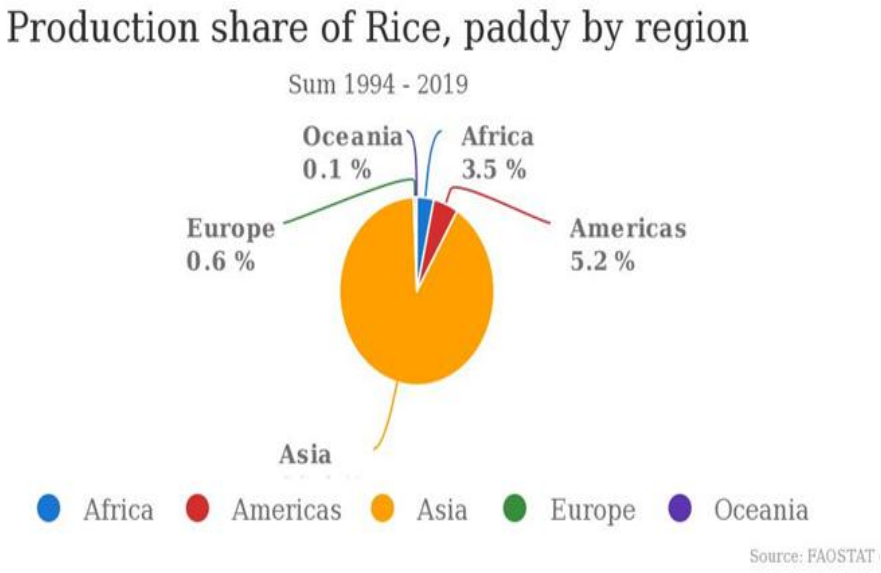
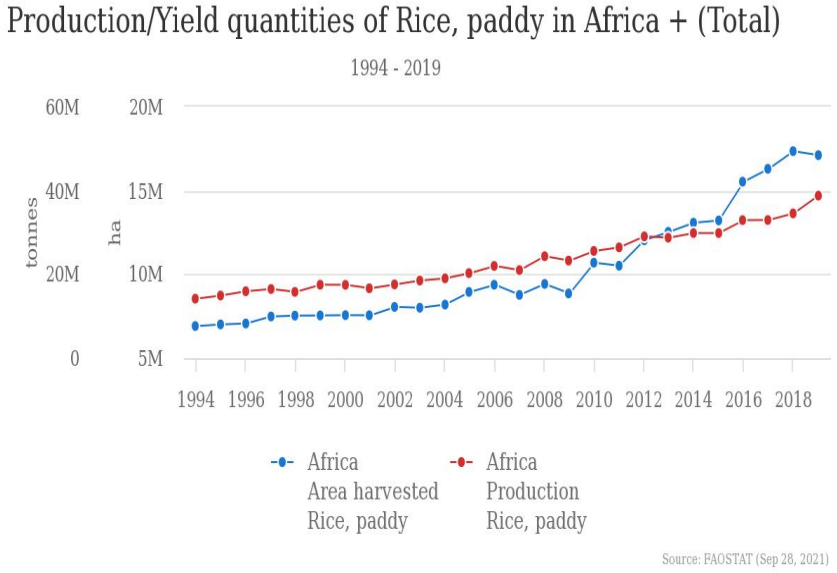
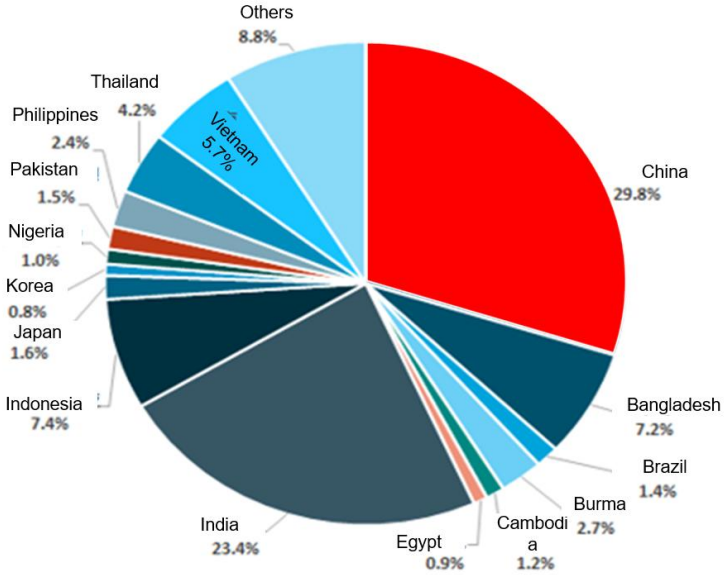
# Part 1
# Overview of Rice Processing
# 稻米加工概述




# 1.1 Current situation of world rice production
# 世界稻米生产现状




- 目前，大米生产国有117个，遍布除去南极洲外的六个大洲，主产区集中在亚洲，亚洲水稻产量占全球水稻产量的91%左右。

  117 rice-producing countries are spread across six continents except Antarctica. About 91% of the world's rice produced in Asia.
- 2019年，中国总产量为2.09亿吨左右,约占世界总产量的29.8%;非洲大米产量为2800万吨。

  By 2019, Africa will produce 28 million tons of rice.  China‘s total production is about 209 million tons,29.8% of the world.
- 中国大米口粮需求占大米总需求的 80%以上。

  China's rice ration demand accounts for more than 80 percent of the total rice demand.
- 从整体上看，整个非洲的稻米产量年均增长5%，非洲自产稻米占总消费量的55%至60%。

**Across Africa as a whole, rice production is growing at an average of 5 percent a year, and Africa** produces 55 to 60 percent of its rice.

# 1.2 Existing problem of rice processing稻米加工存在问题

## 1.2.1 Ubiquity Over processing（过度加工普遍存在）

Comparison of rice processing quality index and nutritional composition in main producing areas

| 级别variety | 留胚率germ-remained（%） | 碎米率broken rice（%） | 白度仪Whiteness meter | | | 留皮度Bran retention（%） | 色差仪Colorimeter | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 白度（%） | 透明度（%） | 精白度 | | L* | a* | b* |
| CHN黄花黏 | 5.00±0.00 | 9.30±0.23 | 41.60±0.21 | 3.25±0.10 | 111.57±2.33 | 0.4 | 63.32±0.32 | 2.08±0.08 | 3.04±0.20 |
| CHN美香黏 | 7.00±0.00 | 11.50±0.00 | 42.90±0.40 | 2.58±0.04 | 74.33±2.65 | 1.1 | 62.49±1.15 | 3.00±0.14 | 2.13±0.25 |
| THAI泰国米 | 1.00±0.00 | 3.20±0.10 | 41.60±0.21 | 3.50±0.11 | 107.00±1.00 | 0.15 | 68.42±1.27 | 2.37±0.09 | 3.22±0.23 |
| JPN新泻县 | 19.50±1.50 | 1.15±0.04 | 42.60±0.63 | 3.79±0.10 | 113.67±2.33 | 0.15 | 63.32±0.35 | 2.08±0.08 | 5.06±0.23 |
| JPN北海道 | 23.05±1.50 | 1.40±0.06 | 39.90±0.50 | 3.86±0.11 | 102.33±2.67 | 0.2 | 61.49±1.05 | 2.00±0.14 | 5.13±0.26 |
| JPN山形县 | 22.50±1.00 | 1.58±0.23 | 47.70±0.20 | 3.72±0.03 | 136.33±0.67 | 0.15 | 68.42±1.57 | 2.29±0.09 | 4.32±0.22 |
| COMBODIA | 1.00±0.00 | 3.20±0.10 | 41.60±0.21 | 3.50±0.11 | 107.00±1.00 | 0.15 | 68±0.03 | 2.12±0.01 | 3.36±0.02 |

| | 脂肪fat（%） | 蛋白protein（干基%） | 直链淀amylose粉（g/100g） | 膳食纤Diet fiber维（%） | $VB_1$ (mg/100g) | Ca (mg/kg) | Fe (mg/kg) | Zn (mg/kg) | Na( mg/kg) | Cd (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| CHN黄花黏 | 0.23±0.09 | 6.78±0.21 | 14.76±0.30 | 2.57±0.08 | 0.103 | 72.1 | 未检出 | 16.4 | 未检出 | 0.08 |
| CHN美香黏 | 0.98±0.02 | 6.69±0.03 | 15.11±0.25 | 2.64±0.12 | 0.1689 | 74 | 未检出 | 23 | 未检出 | 0.09 |
| THAI泰国米 | 0.42±0.03 | 6.03±0.114 | 15.65±0.23 | 2.31±0.10 | 0.0139 | 35.2 | 4.22 | 14.2 | 4.7 | 未检出 |
| JPN新泻县 | 0.59±0.01 | 5.08±0.04 | 8.36±0.30 | 0.38±0.08 | 0.0578 | 35.4 | 0.49 | 17 | 2 | 0.09 |
| JPN北海道 | 0.58±0.02 | 6.52±0.03 | 7.17±0.25 | 0.92±0.12 | 0.0699 | 39.8 | 1.38 | 17 | 7 | 0.03 |
| JPN山形县 | 0.43±0.01 | 4.86±0.04 | 11.65±0.23 | 1.25±0.10 | 0.0583 | 43.8 | 1.5 | 16.7 | 4.94 | 0.12 |
| COMBODIA | 0.42±0.03 | 6.03±0.11 | 2.31±0.04 | 15.35±0.04 | 0.0139 | 35.2 | 4.22 | 14.2 | 4.7 | 未检出 |

# Comparison of the definition of "milling degree" in Rice standard between Internation, China and other countries

| Project | ISO《Rice - 》(ISO7301) | CAC《Rice》(CodexStan198) | 《Rice》（Japan） | 《Rice》（Thailand)(B.E.2540) | 《Rice》USA | 《Rice》(China)(GB1354-86) | 《Rice》(China)(GB1354-2009) | 《Rice》(China)(2018) |
|---|---|---|---|---|---|---|---|---|
| Extra-well-milled rice | Husked , remove all the germ and almost all the rice embryo. | Husked , almost all of the germ , all of the external layers and the largest part of the internal layers of the bran , and some of the endosperm , have been removed. | Entirely milled rice | Remove all the bran layer. The shape is very beautiful. | / | Special grade:back crease has cortex, grain surface cortex basic net accounted for more than 85%. | Level 1 :back crease has not cortex,or back crease has cortex but out of line.More than 90% of rice embryo and grain cortex were removed. | / |
| Well-milled rice | Husk , remove bran layer and part of germ. | Husk , some of the germ and all the external layers and most of the internal layers of the bran have been removed. | / | Bran layer to the net.good-looking appearance. | Husked, removing almost all germ and bran layer. | The standard level 1:back crease has cortex .No more than 1/5 grain bran accounted for more than 80%. | Level 2:back crease has not cortex.More than 85% of rice embryo and grain cortex were removed. | *Back crease mo has not cortex back crease h cortex but out of li 80%- 90% of r embryo and gr cortex we removed , or b retention is bel 2.0%* |
| Reasonably milled rice | / | / | / | Remove most of the bran layer. | Husked, remove part of germ and bran layer. | The standard level 2:back crease has cortex. No more than 1/3 of the grain bran accounted for more than 75%. | Level 3 : back crease has not cortex . No more than 1/5 of the residual granular cortex accounted for more than 80%. | *Back crease h cortex . No m than 1/5 of t granular cort remains in 75 85% . or br retention in 2.0 7.0%.* |
| Milled rice | Can't reach well-millied. | Husked,but not to the degree necessary to meet the requirements of well-milled rice. | Seven tenths milled rice. | Only part of the bran layer was removed. | Can not reach reasonably milled . | The standard level 3 : back crease has cortex . No More than 1/2 of the grain bran accounted for more | Level 4:back crease has not cortex . No more than one fifth of granular cortex residue | / |

Typically , if rice get target, there are three methods to judge the milling degree of rice, the first method is according to contrasting the standard sample. The second method is according to personal experience, and the bove two methods have strong subjectivity. The third method is chemistry staining slowly, cost more.判断大米是否达到目标加工精度的依据为：（1）对照标准样品判断；（2）根据个人经验判断；（3）化学染色法。前两种方法都具有很强的主观性；化学法比较慢，花费高。

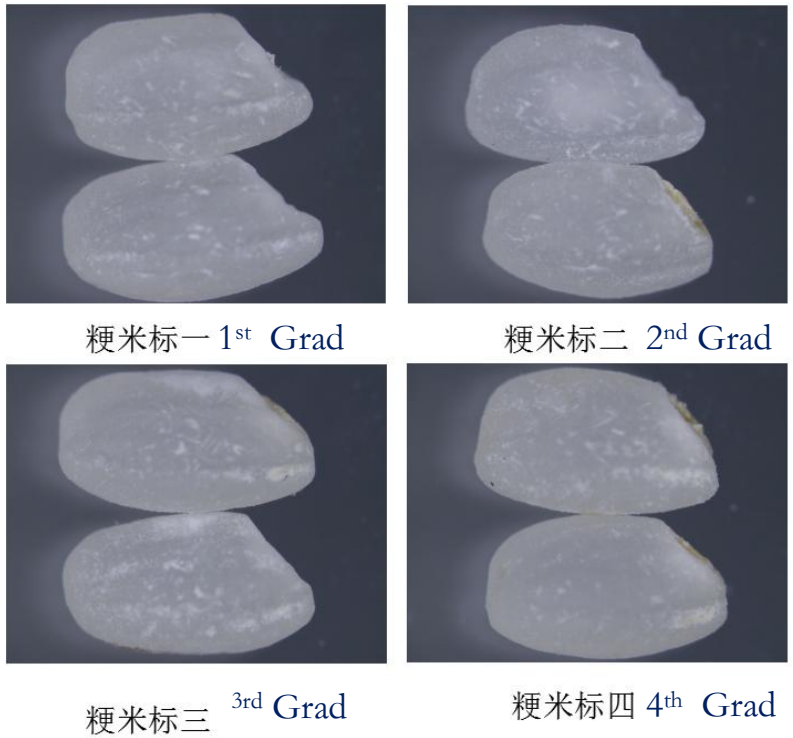



Fig. 1Chinese rice standard samples


Fig.2 Judging the milling degree of rice

# 1.2.2 looking down to processing manage 轻视过程管理

From the follow ing table, we can found that Miller control the milling degree different, and have no way to control accuratly and manage the processing. 从下表可以看到，不同工厂对大米碾磨工艺的控制差别很大，无法实现精准控制和管理。

| 序号 | 信阳光山 20181116 | 碎米率（%） | 留胚率（%） | 留皮度(%) | 判定结果 | 重复性 | 白度 | 透明度 | 精白度 | VB1 (mg/100g) | 钙(mg/kg) | 膳食纤维（%） |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 糙米 | —— | —— | 98.6 | 等外 | 合格 | 21.8±0.2 | 0.8±0 | 0 | 0.102 | 128 | 1.24 |
| 2 | 米机1 | 8.7±0.02 | 34 | 16.4 | 等外 | 合格 | 28±0.4 | 1.3±0.1 | 35.7±1.5 | 0.145 | 83.1 | 0.72 |
| 3 | 米机2 | 9.0±0.07 | 14 | 3.0 | 适碾 | 合格 | 34±0.5 | 2±0.1 | 63.3±2.1 | 0.141 | 68.7 | 0.743 |
| 4 | 米机3 | 15.1±0.05 | 10 | 1.5 | 精碾 | 合格 | 37.5±0.6 | 1.9±0.1 | 78.3±2.3 | 0.122 | 57.4 | 0.244 |
| 5 | 米机4 | 16.8±0.02 | 11 | 0.6 | 精碾 | 合格 | 39.9±0.5 | 2±0.1 | 89±2 | 0.118 | 55.9 | 0.189 |
| 6 | 抛光1 | 13.1±0.06 | 5 | 0.5 | 精碾 | 合格 | 40.1±0.5 | 2.6±0.1 | 94.7±2.1 | 0.09 | 52 | 0.105 |
| 7 | 抛光2 | 9.8±0.04 | 4 | 0.5 | 精碾 | 合格 | 41.1±0.3 | 3±0 | 101±1 | 0.087 | 48.4 | 0.094 |
| 8 | 抛光3 | 9.3±0.08 | 3 | 0.4 | 精碾 | 合格 | 41.6±0.2 | 2.9±0 | 102.7±1.5 | 0.087 | 46 | 0.061 |

| 序号 | 辽宁本溪 20180806 | 平均结果 | | 单次检测结果 | | | |
|---|---|---|---|---|---|---|---|
| | 备　注 | 留皮度(%) | 判定结果 | 重复性 | 留胚率（%） | 白度 | 精白度 |
| 1 | 米机1 | 44.6 | 等外 | 合格 | 94 | 23.8 | 0 |
| 2 | 米机2 | 1.6 | 精碾 | 合格 | 65 | 35.8 | 74 |
| 3 | 米机3 | 0.5 | 精碾 | 合格 | 60 | 38.4 | 89 |
| 4 | 米机4 | 0.4 | 精碾 | 合格 | 53 | 39.3 | 94 |
| 5 | 抛光前 | 0.4 | 精碾 | 合格 | 54 | 39.2 | 95 |
| 6 | 抛光A | 0.3 | 精碾 | 合格 | 52 | 40.3 | 103 |
| 7 | 抛光B1 | 0.4 | 精碾 | 合格 | 46 | 40.1 | 102 |
| 8 | 抛光B2 | 0.3 | 精碾 | 合格 | 50 | 40.4 | 103 |

# 1.2.3 Cost increasing and Benefit decreasing成本增加、效益下降

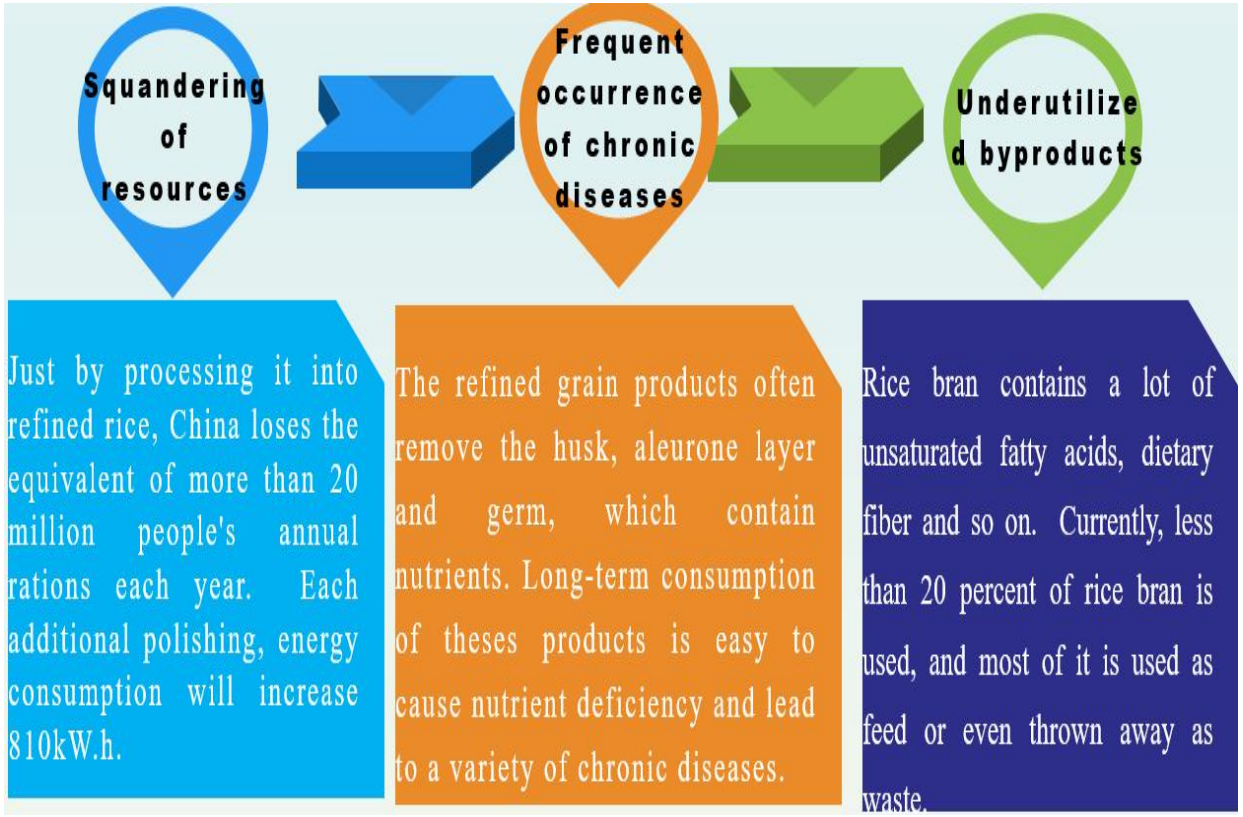
| Rice mill company 公司 | 加工方式 Milling provess | 留皮度/% 1st miller 一碾 | 2nd miller 二碾 | 3rd miller 三碾 | 4th miller 四碾 | 1st polisher 五碾 | 2nd polisher 六碾 | 3rd polisher 七碾 |
|---|---|---|---|---|---|---|---|---|
| 辽宁本溪米业1 | 一砂三铁三抛 | 44.6 | 1.6 | 0.5 | 0.3 | 0.4 | 0.3 | |
| 辽宁盘锦米业2 | 一砂二铁一抛 | 75 | 8.5 | 5.2 | 2.3 | 0.9 | | |
| 信阳光山米业3 | 四砂三抛 | 16.4 | 3.0 | 1.5 | 0.6 | 0.5 | 0.5 | 0.4 |
| 贵州茅贡米业4 | 砂袋碾米 | 68.2 | 57.5 | 24.0 | 3.7 | | | |
| 广州穗粮谷物5 | 三砂一抛 | 14.3 | 2.8 | 0.7 | 0.4 | | | |

**Reason:**

（1）The parameters of miller and polisher distribution depend on the operator experience, are lack of data and scientific basis. 缺少各道米机碾磨量分配依赖于经验，无数据支撑和科学依据。

（2）Over milling and polishing lead to low white rice rate，and power cost increasing.加工精度高，出米率低,电耗增加。

# 1.3 过度加工带来的连锁效应
# The knock-on effects of overprocessing


- Excessive processing results in waste of food resources and loss of nutrients
  **过度加工造成粮食资源浪费、营养成分流失**

# Loss during rice processing 稻谷加工过程中的损失

- **Rice loss:**Brown rice has a theoretical whiteness rate of 90.5% to 92%, but in practice. According to the calculation of brown rice yield, the yield of japonica rice is about 82.3%. The yield rate of indica rice was about 76.6%. This is not only a waste of food, but also a loss of nutrients. 糙米的理论出白率为**90.5% - 92%**，但实际上。按照糙米出米率核算，粳米出米率约为**82.3%**， 籼米出米率约为**76.6%**。这不但造成了粮食浪费，也会造成营养成分的损失。
- **Loss of vitamins:**. Take vitamin B1 as an example, generally contains 0.35 ~ 0.45 mg per 100 grams of brown rice, and only 0.11 mg per 100 grams of white rice. 维生素的损失：以维生素$B_1$为例，每百克糙米中一般含有**0.35～0.45**毫克，而每百克白米中仅含**0.11**毫克。
- **Loss of protein and fat:** The higher the accuracy of rice, the greater the loss of protein and fat. Protein loss is mainly albumin and globulin. **蛋白质及脂肪的损失：**大米精度越高，蛋白质和脂肪的损失越大。蛋白质损失的主要是清蛋白和球蛋白。
- **Starch loss:** mechanical milling of rice damage endosperm to a certain extent, resulting in starch loss. The higher the accuracy of rice, the greater the loss. The deeper the furrows on the surface of brown rice, the greater the loss of starch. **淀粉的损失：**机械碾米对胚乳存在一定程度的损害，从而造成淀粉的损失。大米精度越高，损失越大。糙米表面的沟纹越深，淀粉的损失越大。
- **Mineral loss:** 矿物质的损失也比较大。

大米蒸煮后为什么有香味？ Why does rice smell good after cooking?

| Compound name | RI | NIST Spectral library RI | Odor characteristics | 含量（μg/kg） 糙米Brown rice bran degree留皮度98.8% 31kinds | DOM 6.0% bran degree留皮度5.4% 24kinds | DOM 12.0% bran degree留皮度0.2% 26kinds |
|---|---|---|---|---|---|---|
| **酮类 ketones** | | | | | | |
| 2-戊基癸酮 2-amyl decanone | 1701 | 1698 | 水果味fruit | 422.31±55.18$^{b}$ | 416.87±29.22$^{b}$ | 249.32±0.06$^{a}$ |
| 2-吡咯烷酮2-pyrrolidone | 1115 | 1077 | | —— | 25.43±0.39 | —— |
| 2,4,6-辛烯酮Octene ketone | 1040 | —— | | —— | —— | 23.61±2.19 |
| 2-十七烷酮2-heptadecanone | 1904 | 1900 | | —— | —— | 210.45±14.6 |
| 法尼基丙酮Farniki acetone | 1924 | 1920 | 花香 flowers | —— | —— | 125.28±14.59 |
| **酯类esters** | | | | | | |
| Gamma - nonyl lactone | 1359 | 1362 | 桃子味Peach flavor | 167.27±21.16 | —— | —— |
| 邻苯二甲酸二甲酯Dimethyl phthalate | 1469 | 1466 | | 69.74±9.33$^{a}$ | 59.07±0.42$^{a}$ | —— |
| 甲基十六酯Methyl hexadecyl | 1659 | —— | | 137.59±1.47 | —— | —— |
| 邻苯二甲酸二异丁酯Diiso-butyl phthalate | 1878 | 1872 | 轻微香气Mild aroma | 600.32±77.29$^{b}$ | 335.44±38.18$^{a}$ | 214.88±22.13$^{a}$ |
| 邻苯二甲酸二丁酯Dibutyl phthalate | 1974 | 1967 | 芳香气Fragrant breath | 5220.26±311.49$^{a}$ | 5989.5±525.73$^{a}$ | 6875.37±870.6$^{a}$ |
| 亚硫酸己基十六基酯Hexyl hexyl sulfite | 1555 | —— | | —— | —— | 72.53±11.38 |
| 棕榈酸甲酯Methyl palmitate | 1926 | 1928 | 茶香、果香Aroma of tea and fruit | —— | —— | 130.09±14.74 |
| 对甲氧基肉桂酸辛酯Octyl p-methoxy cinnamate | 2175 | —— | | —— | —— | 138.58±13.65 |
| **酸类acids** | | | | | | |
| 十四酸；肉豆蔻酸Myristic acid; Nutmeg acid | 1779 | 1765 | 烧焦、奶酪味Burnt and cheesy | 6547.56±758.9$^{c}$ | 3547.73±93.13$^{b}$ | 354.89±0.52$^{a}$ |
| **其他others** | | | | | | |
| 2-甲氧基呋喃2-methoxy furan | —— | —— | | 2.34±0.16 | —— | —— |
| 2-乙基呋喃2-ethyl furan | 729 | 712 | | 2.4±0.14 | —— | —— |
| 2-戊基呋喃2-amyl furan | 988 | 987 | 果香、花香味Fruity, floral fragrance | 470.47±37.37$^{b}$ | 82.44±2.91$^{a}$ | 77.29±1.39$^{a}$ |
| 2,3-二氢苯并呋喃2, 3-dihydrobenzofuran | 1226 | 1219 | 甜香、坚果香Sweet and nutty | 12610.96±1118.5$^{c}$ | 6813.81±849.6$^{b}$ | 1166.83±145.8$^{a}$ |
| 吡啶pyridine | 724 | 753 | | 6.87±0.6 | —— | —— |
| 2-乙酰基吡咯啉2-acetyl pyrroline | 916 | 922 | 爆米花香Popcorn aroma | 123.94±11.26$^{c}$ | 54.17±2.5$^{b}$ | 38.71±0.91$^{a}$ |
| 吲哚Indole | 1288 | 1287 | 焦油，樟脑Tar, camphor | 150.61±12.61$^{b}$ | 149.26±10.99$^{b}$ | 81.48±8.34$^{a}$ |
| 2-甲基萘2 - methyl naphthalene | 1296 | 1315 | | 132.93±15.52$^{c}$ | 52.07±1.5$^{b}$ | 20.71±0.95$^{a}$ |

标准品比对 standard

有 有

碾磨使有利的风味物质大量损失，因此，应降低加工精度

Milling results in a large loss of beneficial flavor substances, so the processing accuracy should be reduced

减少了90.7%

减少了68.8%

2-乙酰基吡咯啉是仅在香米中存在的挥发性物质，阈值低，加工过程使其大量损失。2- acetyl pyrroline is a volatile substance that exists only in fragrant rice, with a low threshold and a large amount of loss during processing.

注：谱库RI来源于

# 1.4 Development trend of rice processing industry
# 稻米加工业发展趋势

- **安全健康——慢性病频发.**

  **Safe and healthy rice: chronic diease frequent occured.**

- **美味、方便——** **Tasty， convenience to enjoy.**

- **精准适度与绿色低耗加工——产业发展的必然选择**

  **Accurate and moderate processing，green and low comsumption.**

- **资源利用度和产品多样性——技术和产品两者创新的重点.**

  **Resource availability and product variety.**

河南工業大學
HENAN UNIVERSITY OF TECHNOLOGY

# Part 2

# Technology & Equipment of Reducing Rice Loss

# 稻米加工减损技术与装备




# 2.1 The Aim of Rice Milling

- **To attain the highest yield of white rice**
- **With the best quality**
  - **Remove least amount of hull（稻壳） and bran（米糠）**
  - **Minimum brokenes**
  - **Little foreign matter**

From wheat to wheat Flour 小麦到面粉

# 2.1 稻谷加工工艺流程 Rice processing technology

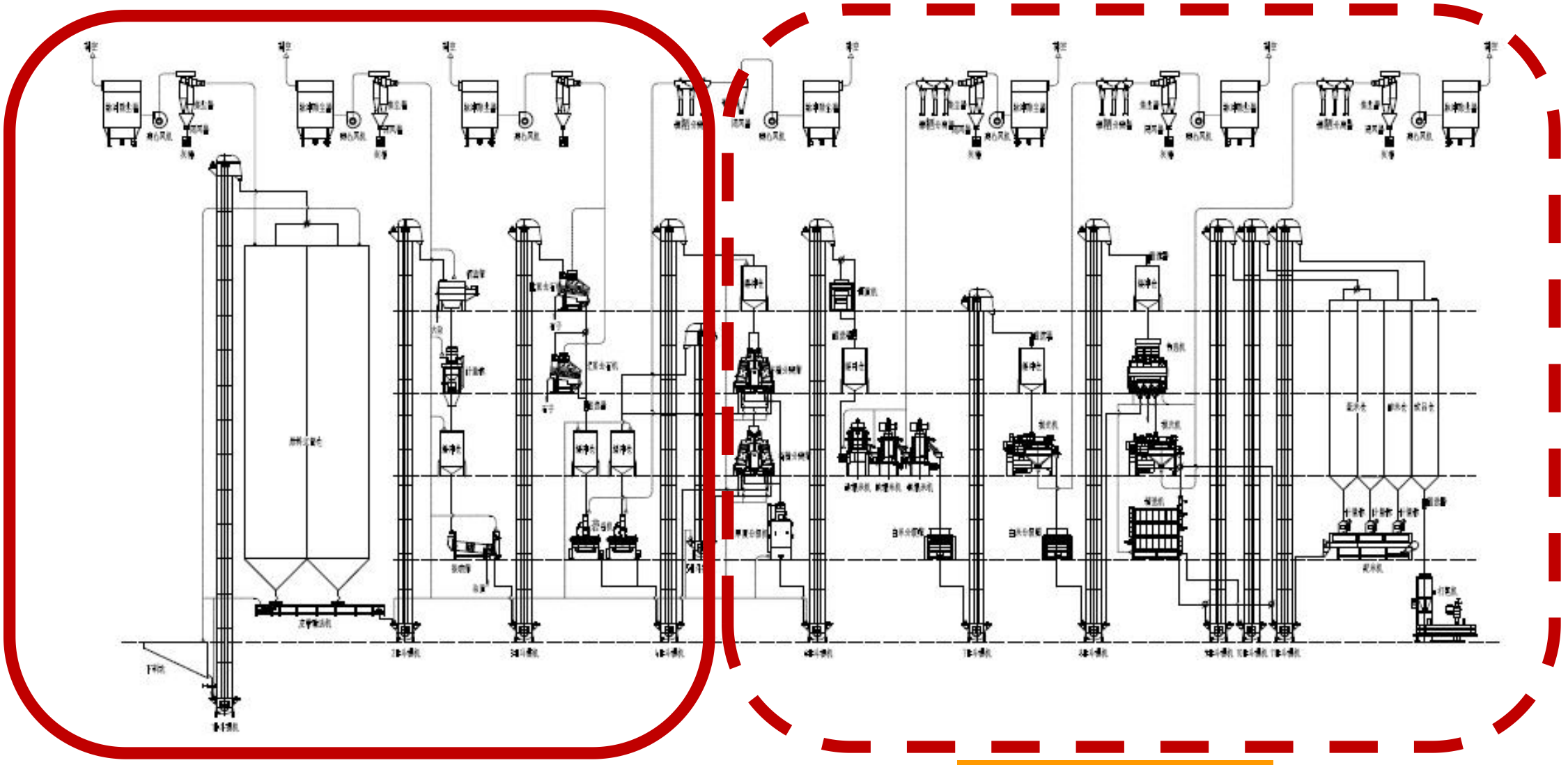
除杂清理
Cleaning

砻谷
Hubrang

碾米
Rice milling

成品米
Milled rice

# Technological Process of 200,000 tons rice annually
# 年加工20万吨稻谷大米生产线工艺流程



Cleaning process

Milling process

# 2.1.1 稻谷清理工艺Rice cleaning technology

**净谷标准：**含杂总量≤0.6%，

Clean paddy standard：total Impurity containing ≤0.6%，

其中： 砂石≤1粒/kg，稗子≤130粒/kg

Among: sand≤1grain/kg， Barnyardgrass ≤130graimn/kg

- **风选法**——利用空气动力学特性的不同

wind sifting methods --Using different aerodynamic characteristics

- **筛选法**——利用宽度与厚度的不同

screening method-- Using different width and thickness characteristics

- **比重分选法**——利用比重的不同

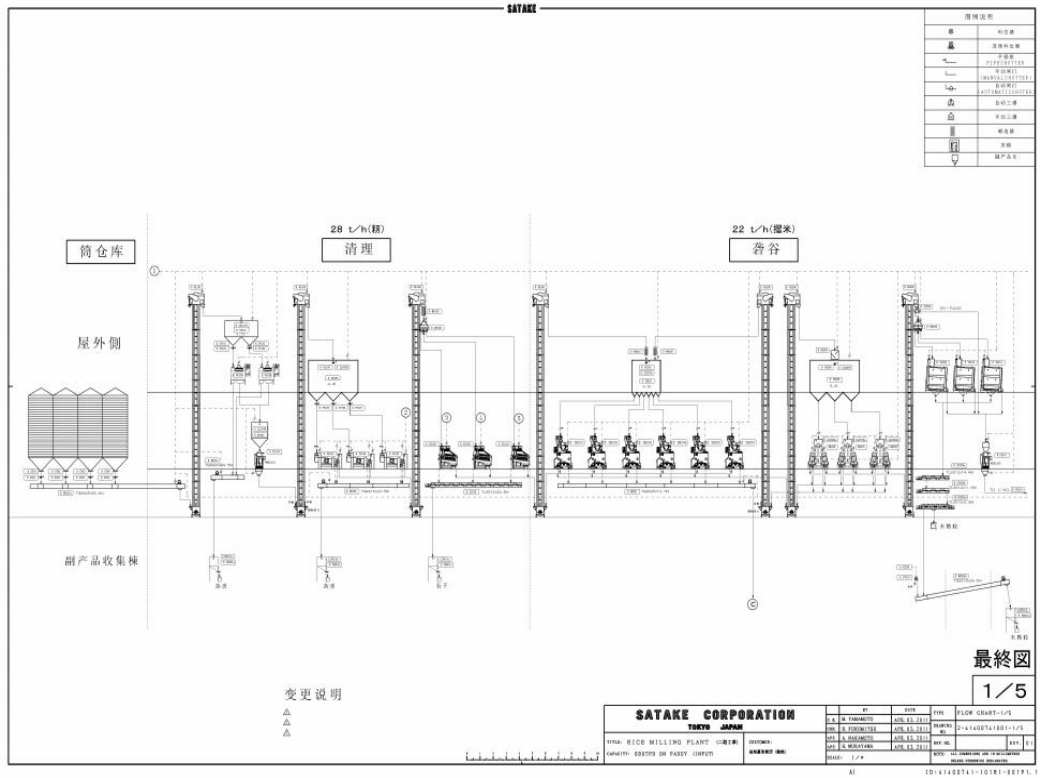
Specific Gravity Sorting Technology-- Using different specific gravity

- **磁选法**——利用磁性的不同

magnetic separation-- Using different magnetic

- **光电分选法**——利用颜色的不同

photometric separation-- Using different color

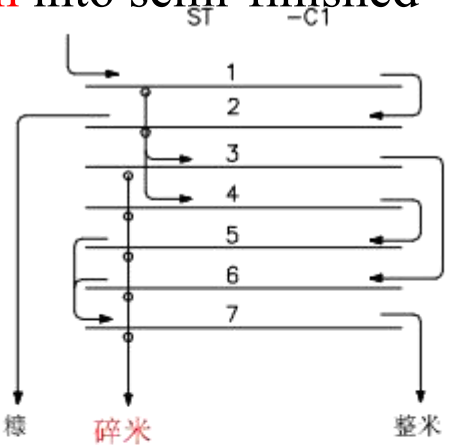


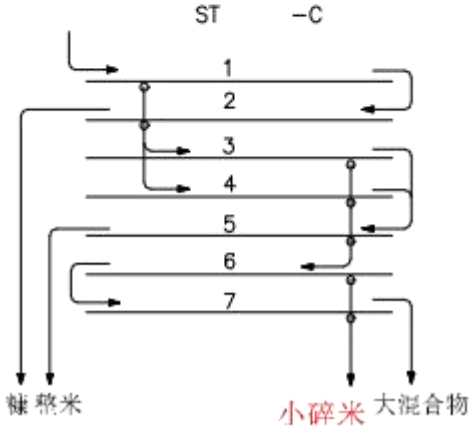
# 2.1.2 砻谷碾米工艺 Hubrang and rice milling process

稻谷加工是指对稻谷进行清理、砻谷及砻下物分离、碾米等工业化处理制成半成品粮、成品粮、米制食品及其他产品的过程。

Rice processing refers to the industrial process of cleaning, hubrang, separation of them into semi-finished grain, milled rice, rice food and other products.





# Example :Parameters of husker in the line

| 设备名称 | 设备型号 | 合同规定工艺指标 |
|---|---|---|
| 砻谷机 | DRHE Goodies① | 脱壳率>90%；糙碎：冬季<3%，夏季<2%，糙米含稻壳率<0.5%，稻壳含饱满粮<30粒/kg 稻壳 |
| | DRHE Goodies① | |
| | DRHE Goodies② | |
| | DRHE Goodies② | |
| | DRHE Goodies③ | |
| | DRHE Goodies③ | |
| | 平局值 | |

| Device name | Device model | The contract specifies the process specifications |
|---|---|---|
| Paddy Separator | DRHE Goodies① | Hulling rate>90%；crushed brown rice：winter<3%，summer<2%，Rate of brown rice with rice husk<0.5%，Rice hulls with full grain percentage<30 grains/kg rice husk |
| | DRHE Goodies① | |
| | DRHE Goodies② | |
| | DRHE Goodies② | |
| | DRHE Goodies③ | |
| | DRHE Goodies③ | |
| | Tie-breaker value | |

| 设备名称 | 设备型号 | 检测项目 | | | | | | 备注 |
|---|---|---|---|---|---|---|---|---|
| | | 样品量（g） | 含碎率（%） | 脱壳率（%） | 设备型号 | 样品量（%） | 稻壳含饱满粮率（%） | |
| 砻谷机 | DRHE Goodies① | 25.36 | 1.17 | 94 | DRSD Rice husk① | 63.63 | 未检出 | |
| | DRHE Goodies① | 28.62 | 1.39 | 96 | DRSD Rice husk① | 65.72 | 未检出 | |
| | DRHE Goodies② | 25.82 | 1.28 | 94 | DRSD Rice husk② | 58.42 | 未检出 | |
| | DRHE Goodies② | 22.38 | 1.31 | 95 | DRSD Rice husk② | 60. 12 | 未检出 | |
| | DRHE Goodies③ | 23.36 | 1.46 | 96 | DRSD Rice husk③ | 63.26 | 未检出 | |
| | DRHE Goodies③ | 24.16 | 1.27 | 92 | DRSD Rice husk③ | 62.67 | 未检出 | |
| | 平局值 | 24.95 | 1.31 | 94.5 | 平局值 | 62.3 | 未检出 | |

| Device name | Device type | Detect items | | | | | | Remark |
|---|---|---|---|---|---|---|---|---|
| | | Sample volume（g） | Contains crushing rate（%） | Hulling rate（%） | Device model | Sample volume（%） | Rice hulls with full grain percentage | |
| Paddy Separator | DRHE Goodies① | 25.36 | 1.17 | 94 | DRSD Rice husk① | 63.63 | Not checked out | |
| | DRHE Goodies① | 28.62 | 1.39 | 96 | DRSD Rice husk① | 65.72 | Not checked out | |
| | DRHE Goodies② | 25.82 | 1.28 | 94 | DRSD Rice husk② | 58.42 | Not checked out | |
| | DRHE Goodies② | 22.38 | 1.31 | 95 | DRSD Rice husk② | 60. 12 | Not checked out | |
| | DRHE Goodies③ | 23.36 | 1.46 | 96 | DRSD Rice husk③ | 63.26 | Not checked out | |
| | DRHE Goodies③ | 24.16 | 1.27 | 92 | DRSD Rice husk③ | 62.67 | Not checked out | |
| | Tie-breaker value | 24.95 | 1.31 | 94.5 | Tie-breaker value | 62.3 | Not checked out | |

# Control Factors for Operating Paddy Separators

- **Paddy Count(糙米中稻谷数量) – The number of paddy kernels(≤ 40grains/kg) present in a 1kg brown rice sample.**
- **Return Brown Ratio(稻谷含糙率) – The percentage of brown rice in the husker return stream (≤ 30grains/100kg).**

# Rules For Operating Brown Rice Preparation Process

**1. Treat the process as a whole.**

**2. Set hubrang ratios, paddy counts and return brown ratios individually(设定).**

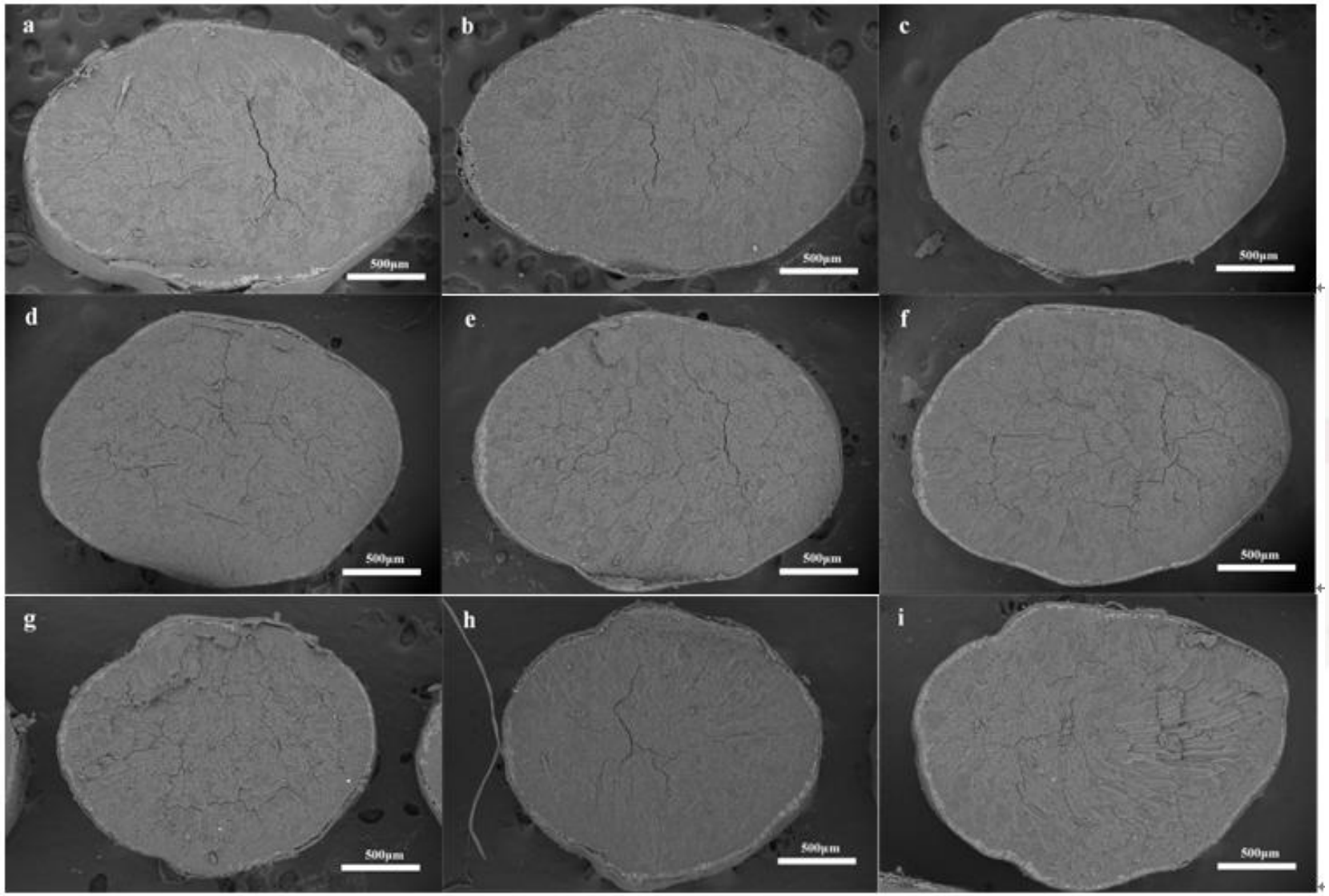
**3. Monitor hubrang ratios, paddy counts and return brown ratios as composites（检测）**

**4. If composite samples indicate a problem, go to the source of the problem**

# 2.2 如何实现精准适度加工呢？减少损失和浪费？

**How to achieve accurate and moderate processing?**
**How to Reduce loss and wasteduring rice processing?**

# 2.2.1 糙米的微观结构与特性分析 Microstructure and property of brown rice



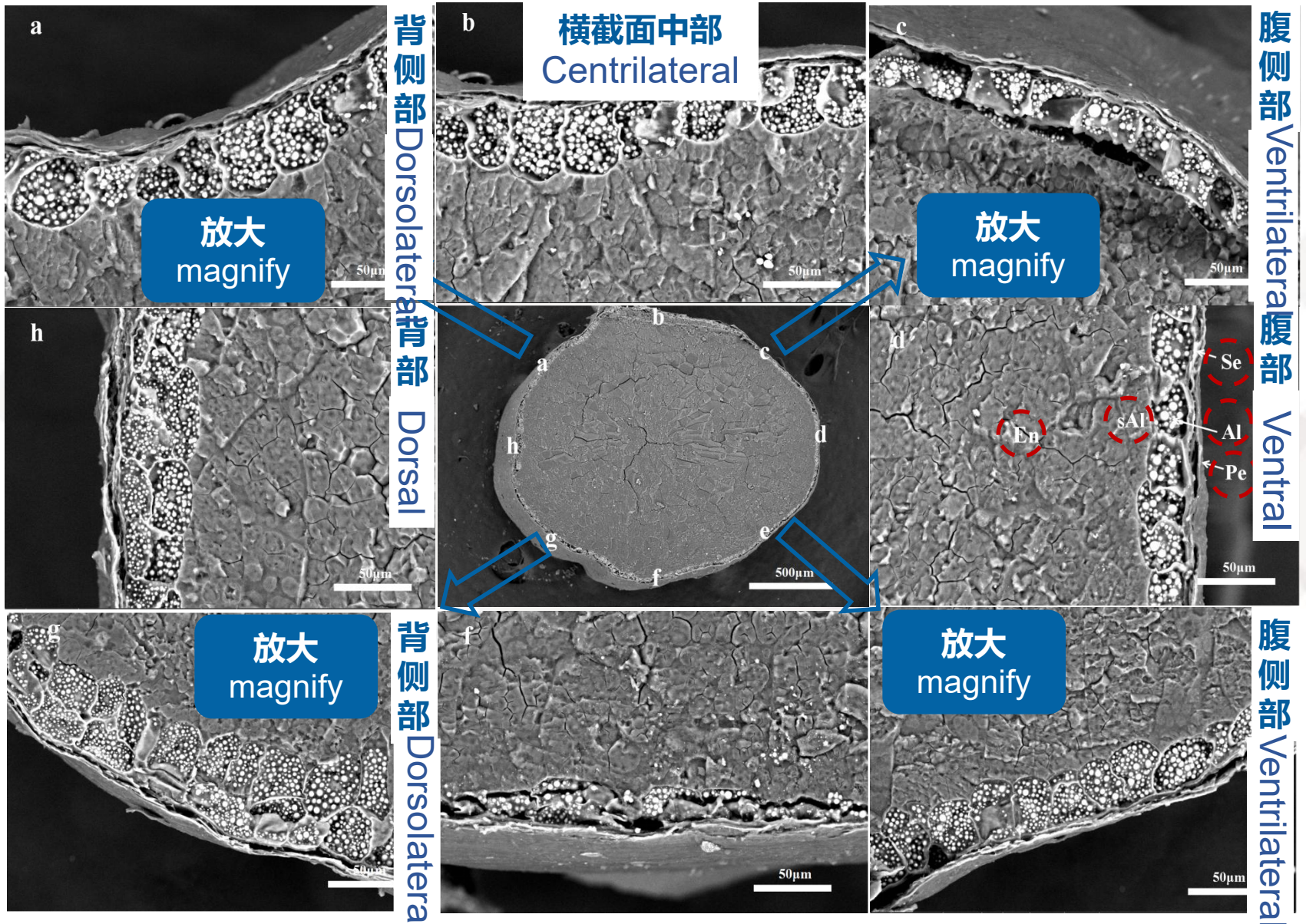

Note:
a, b, c for Japanese japonica rice varieties: Yan ji, Akita small town, Koshihikari;
d, e, f, japonica rice varieties in the north of China, Jilin Super Rice, YuanYang, Liaoning ;
g, h, I, indica rice varieties in the south of China: Sharuanzhan, Meixiangzhan, Tianlong No. 1.
The magnification is 150 X.

注：a-i为9个品种糙米横截面的扫描电镜图片，a、b、c为日本粳型糙米品种：艳姬、秋田小町、越光的糙米横截面，d、e、f为我国北方粳型糙米品种：吉林超级稻、原阳大米、辽粳糙米横截面，g、h、i为我国南方籼型糙米品种：沙软粘、美香粘、天龙一号糙米横截面。放大倍数均为150 X。

**图1 粳糙米和籼糙米糙米横截面SEM图像**

**Fig. 1** Scanning electron microscope (SEM) of transverse section of brown rice

# 2.2.2 糙米皮层结构观察 Microstructure of bran in brown rice




**背部糊粉层厚度：30- 45μm，约2-3层；**

**腹部糊粉层厚度：15- 20μm，约1层。**

Dorsal aleurone layer thickness: 30-45 μm, about 2-3 layers; Ventral aleurone layer thickness: 15-20 μm, about 1 layer.

**图2 某种籼型糙米横截面及其不同部位扫描电镜图** Fig.2 SEM of cross section and different parts of indica brown rice

**稻谷的遗传特性是影响稻谷品质的决定性因素。尽管如此，在原料品种确定的条件下，生态环境条件、培育技术、加工技术和贮藏对稻谷品质有着关键作用，从而影响稻米加工流通环节的质量和损耗。**The genetic character of rice is the decisive factor affecting rice quality. Though the raw material variety is determined, the ecological environment conditions, cultivation technology, processing technology and storage play a key role in the quality of rice, thus affecting the rice quality and wastage.

**出米率与糙米的籽粒构型、理化特性及加工工艺有关。**与出米率相关的糙米籽粒结构形态主要是糙米籽粒的形状、皮层厚度、胚乳结构。

The rice yield is related to the grain shape, physical and chemical properties and milling technology of brown rice. The grain shape, cortex thickness and endosperm structure of brown rice are critical to the rice yield.

# 2.3 不同含水率糙米力学特性分析与位移特征
# Analysis of mechanical properties and characteristic shift of brown rice with different moisture content

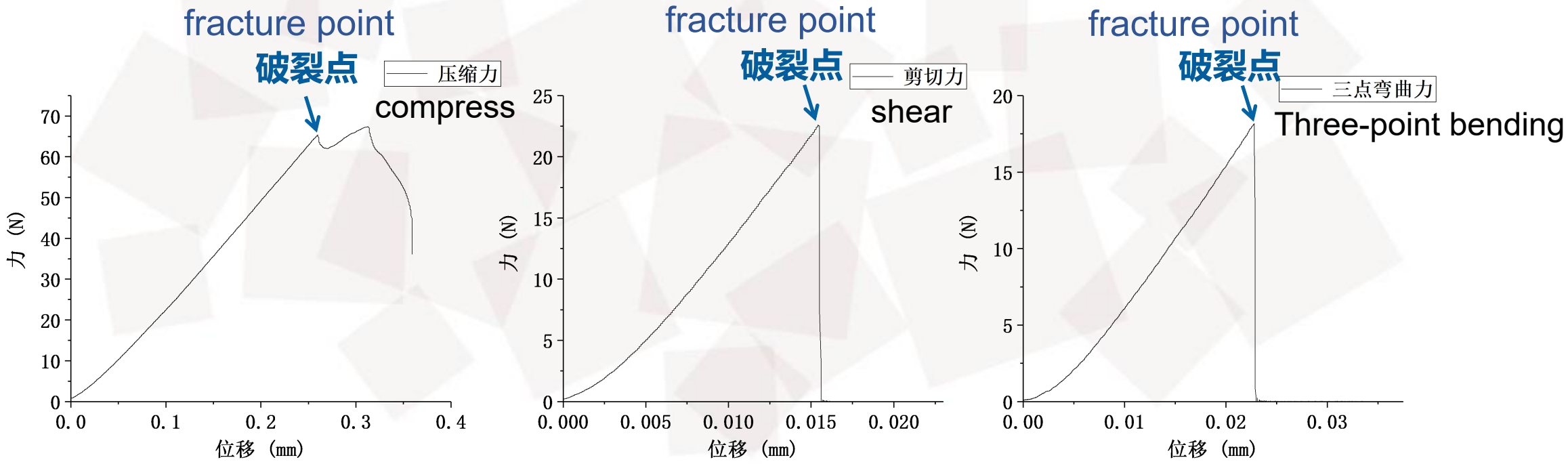



图3 糙米力与位移特征曲线图

Fig. 3 Force and shift curves of brown rice

# 糙米尺寸与力学特性的相关性
# Correlation between dimensions and fracture force of brown rice

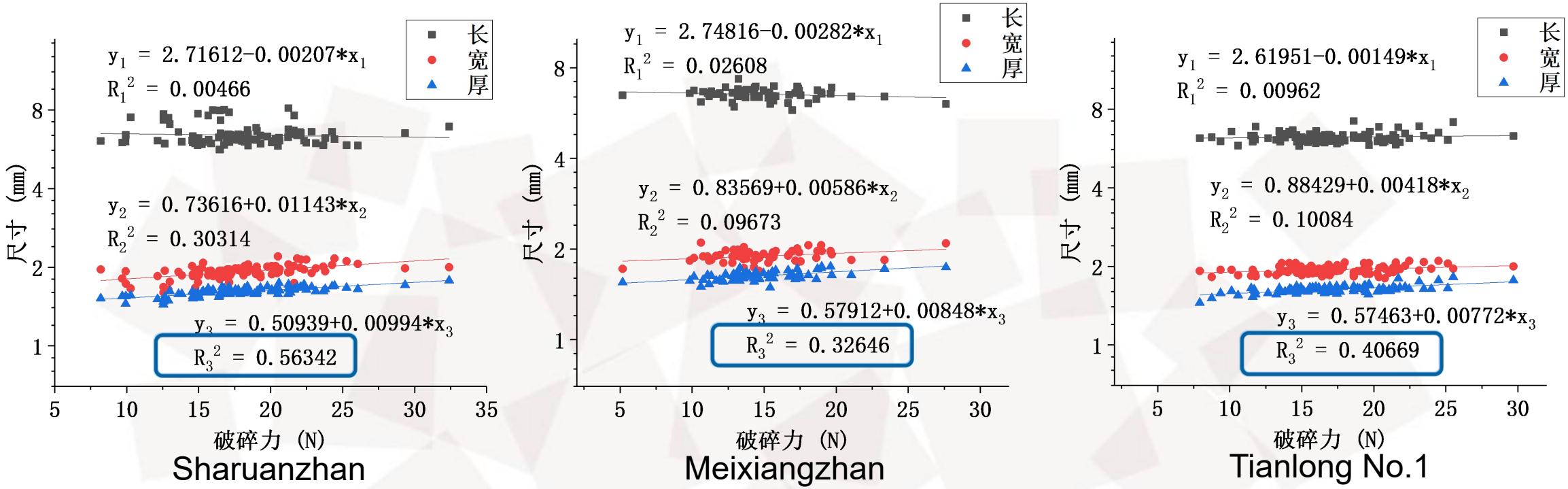


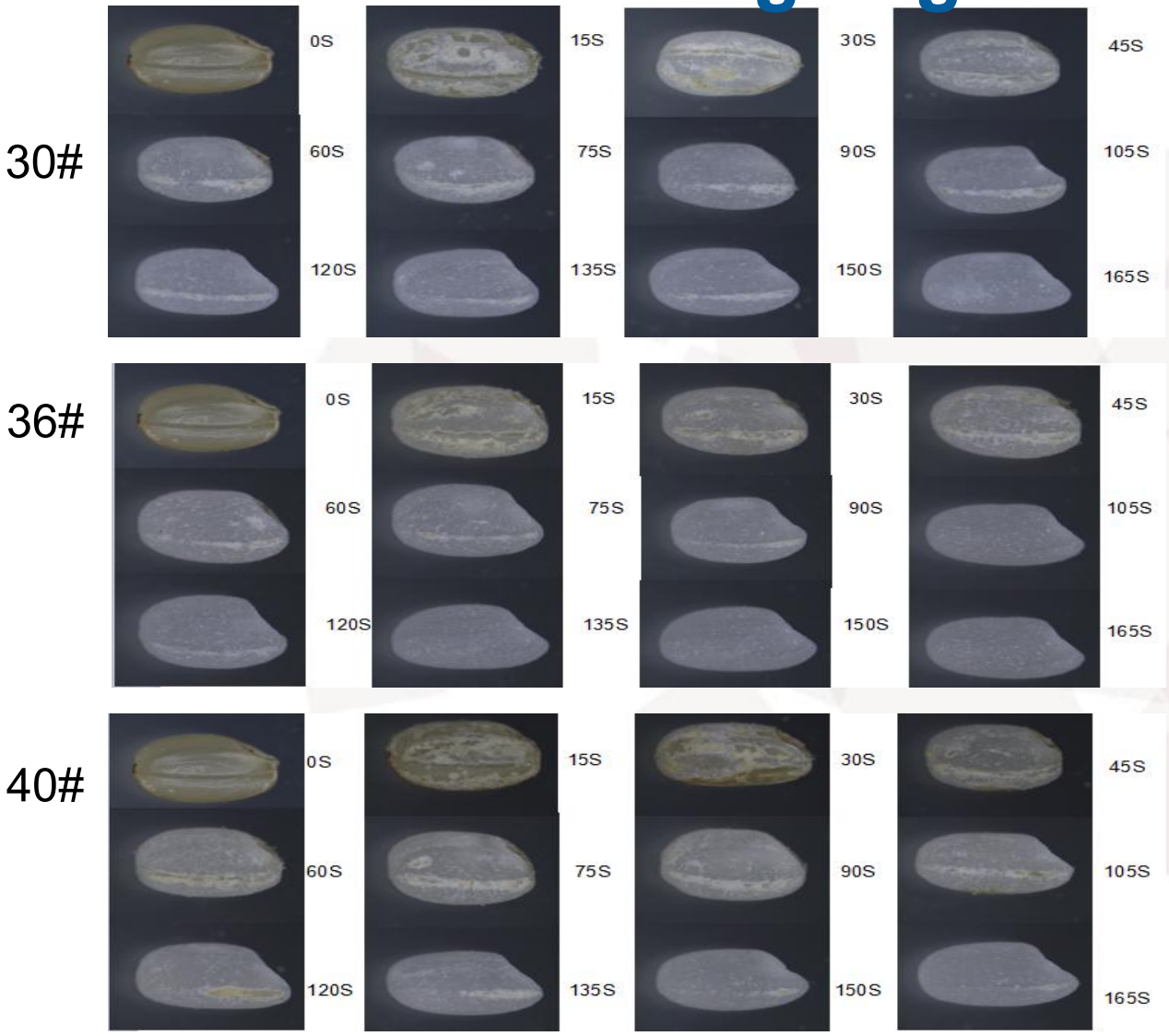

**图5 糙米尺寸与破碎力相关性 Fig.5 Correlation between dimensions and fracture force of brown rice**

**厚度值越高，破碎力相对越高。即，厚度大的籽粒在受折断力时需要发生更大的形变，承受更大的力，从而堆积裂纹使其破裂，一定程度上说明较厚的籽粒抵抗破裂变形的能力越强。**

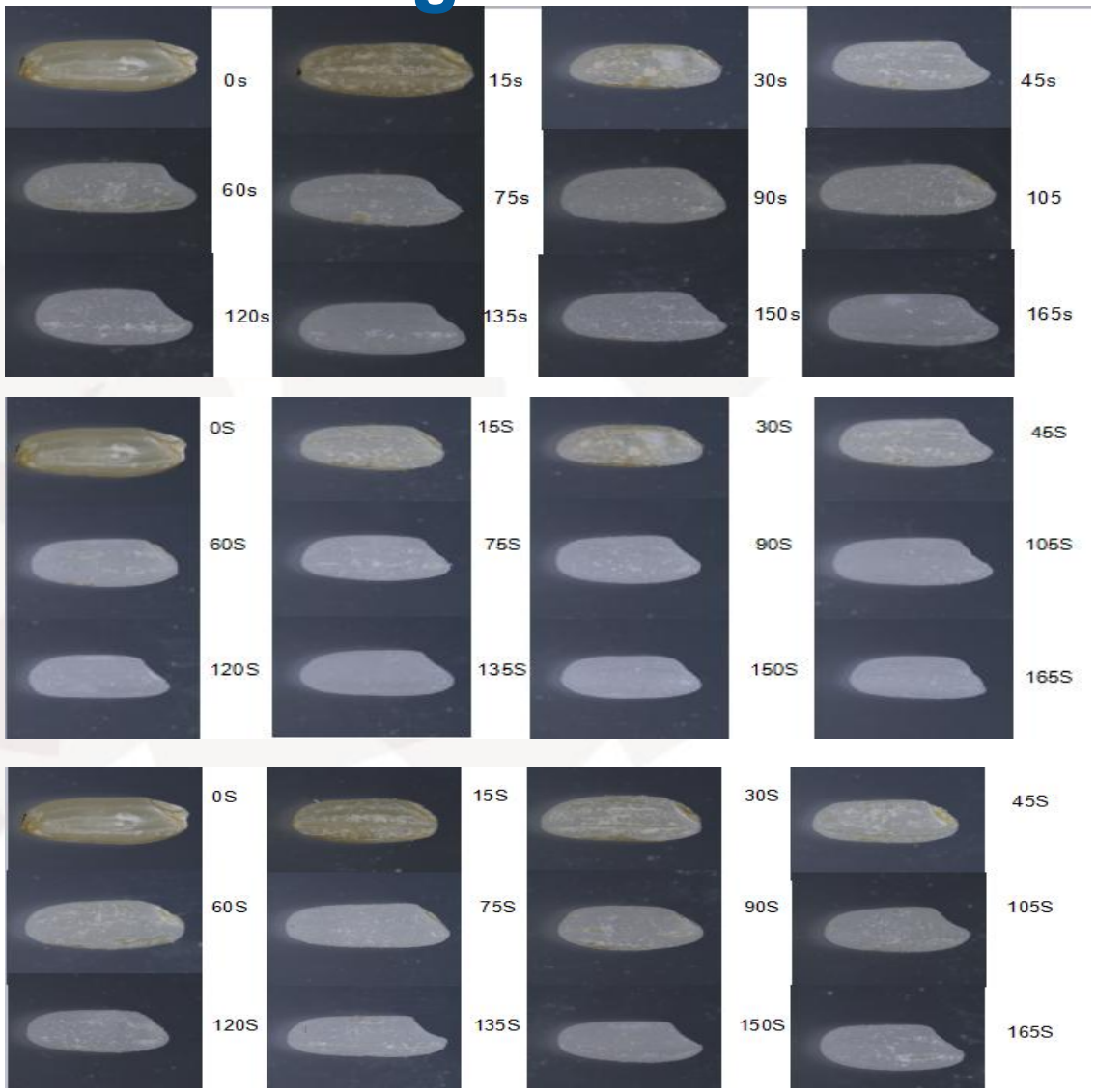
The higher the thickness value is, the higher the broken force is. In other words, when the grain with larger thickness is subjected to frature force, it needs to undergo greater deformation and bear greater force, thus accumulating cracks to break it. To some extent, it indicates that the thicker grain has a stronger ability to resist fracture deformation.

# 2.4 碾磨程度对大米皮层结构的影响

## Effect of milling degree on the bran degree

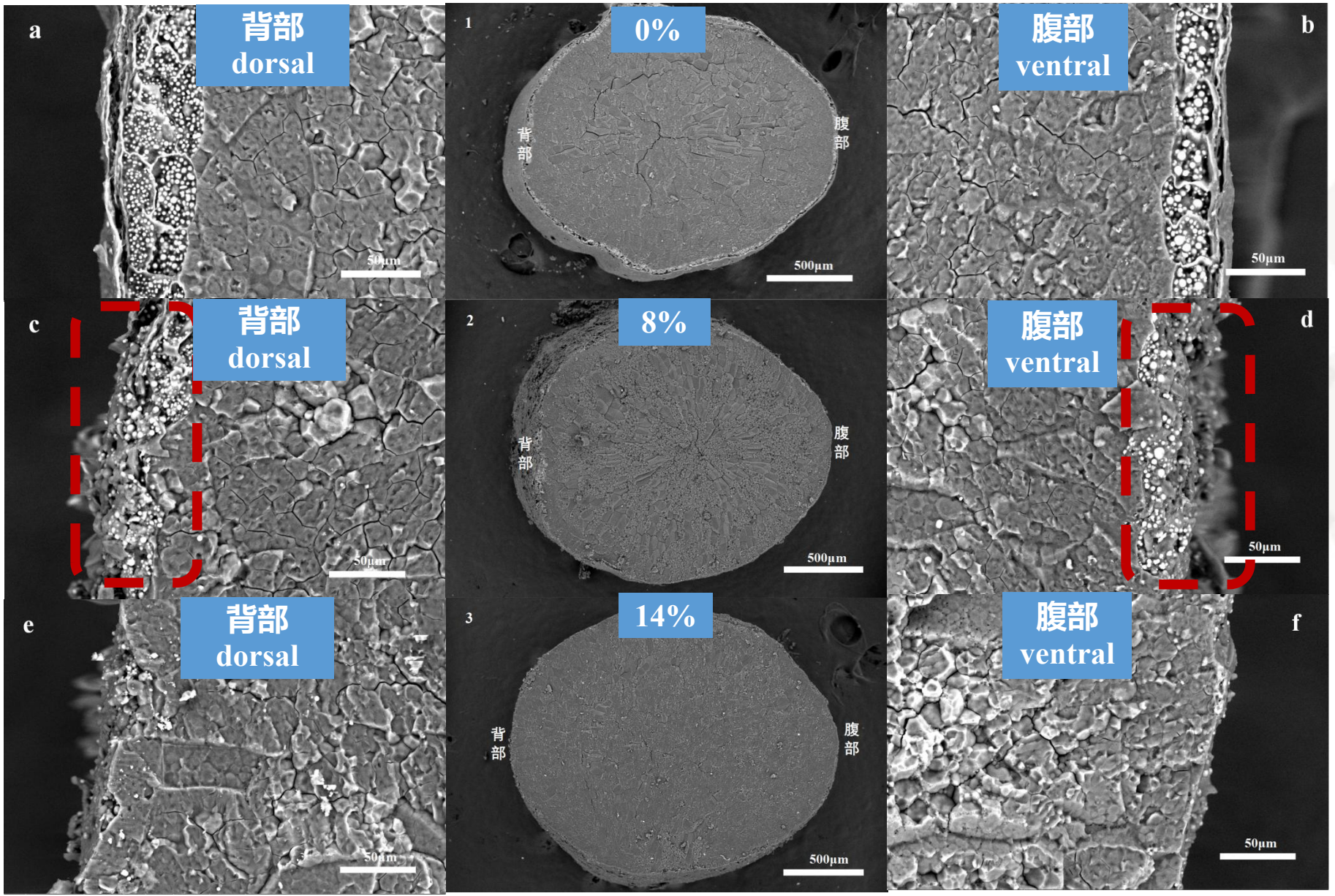



短粒米 short grain




长粒米 long grain

# 2.4.1 碾磨程度对大米皮层结构的影响
# Effect of milling degree on the bran




某种籼米横截面背部腹部扫描电镜图像

SEM of the dorsal and ventral of an indica rice

- 1.碾减率越高，大米横截面褶皱减少，并变圆滑；

The higher the milling degree, the less fold and smoother the cross section of rice;

- 2.碾减率8%果皮层和种皮层去除，糊粉层保留较多；碾减率14%糊粉层结构几乎全部消失。

Paricarp and seed coat were removed with a milling degree of 8%, while aleurone was ret ained. The aleurone al most disappeared with milling degree of 14%.

碾磨程度对背部、腹部糊粉层的影响

Effect of grinding degree on aleurone layer of back and abdomen

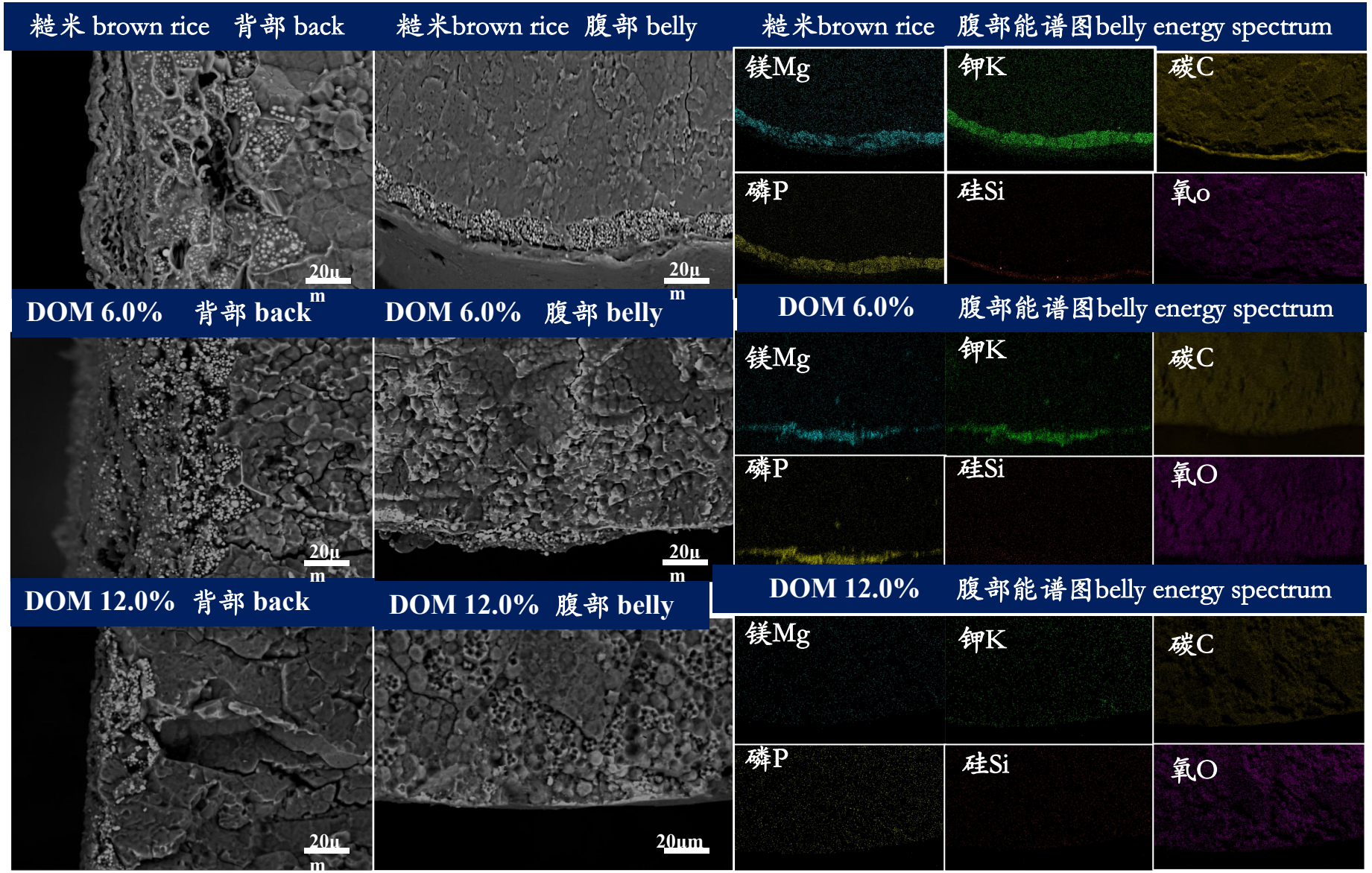
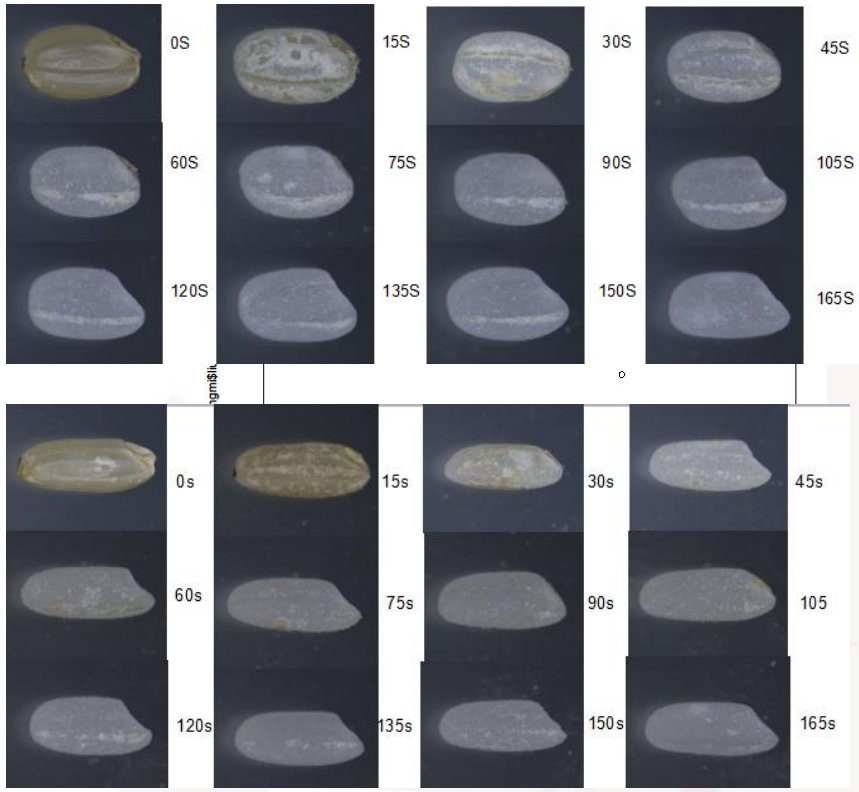
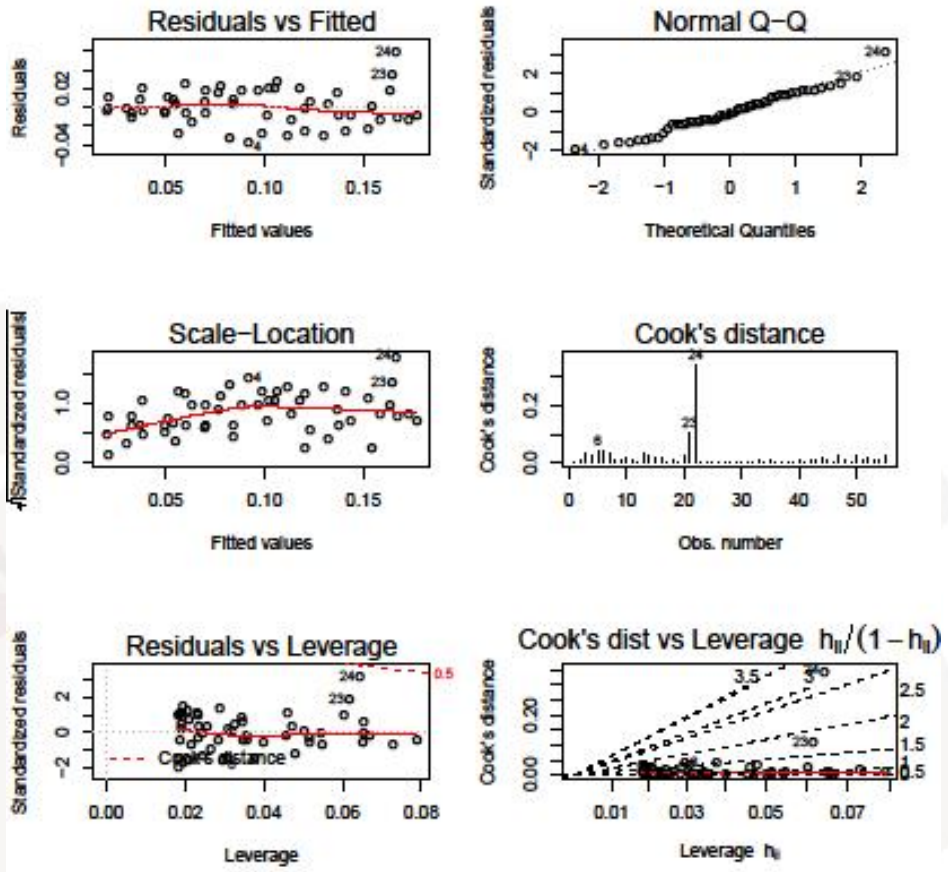



**图10 某种粳米不同加工精度大米背部和腹部扫描电镜图和能谱图**

**Fig 10. Sem and EDS of back and belly of a certain japonica rice with different processing accuracy**




白度对碾减率的线性模型(粳米模型)

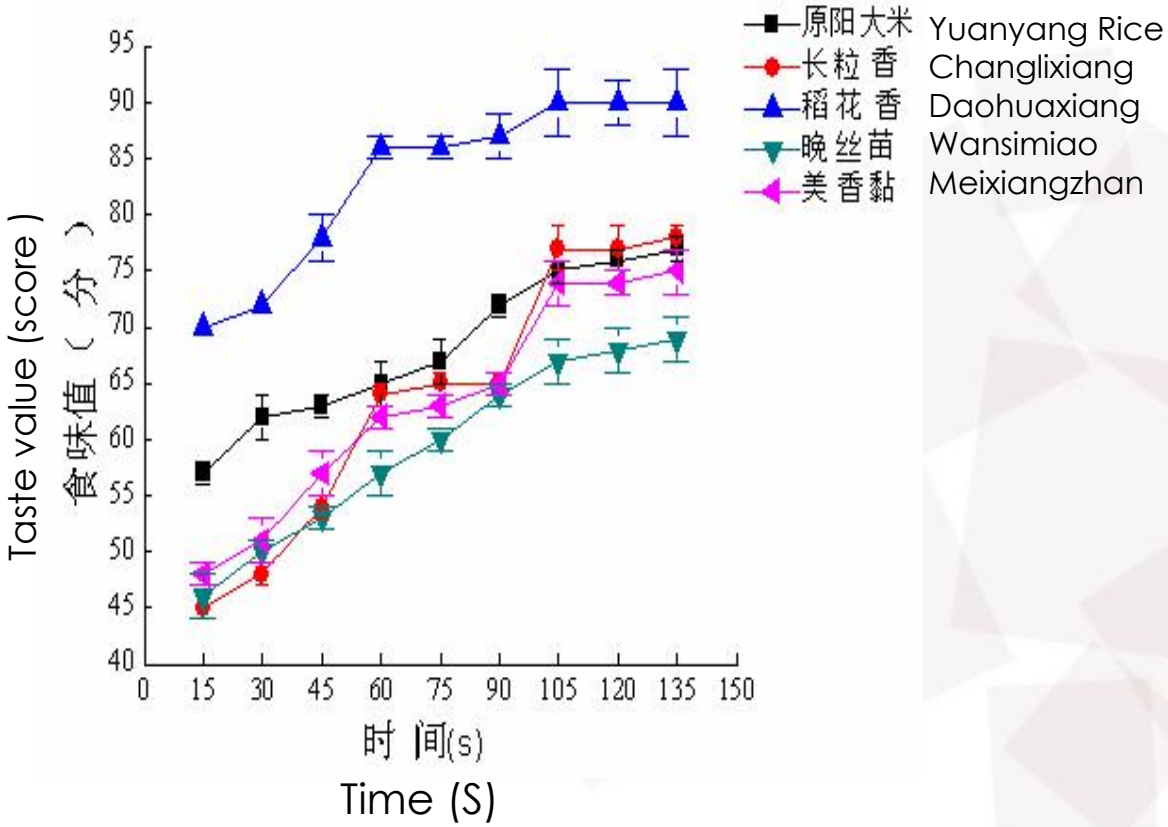
碾减率 = -0.1246740 + 0.0054540×白度;

log（留皮度）= 32.0097-8.6270×log（白度）

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.1057474  0.0106095  -9.967 3.47e-11 ***
bai du mean  0.0057470  0.0003192  18.006  < 2e-16 ***
```

# 2.4.2 碾磨程度对米饭食味值的影响（客观评价）

## Effects of Milling Degree on Taste value of cooked rice (Objective Evaluation)




米饭的食味值(米饭食味仪测定)
The taste value of rice(Determination of rice taste apparatus)

- ✓ **食味值增长到一定趋势后趋于平稳趋势。**
- ✓ **Taste value increases to a certain trend and then tends to stabilize**
- ✓ **留皮度在2.0-6.2之间，蒸煮指标基本稳定，米饭质构指标以及米饭食味值都保持在较好的水平；但品种之间有较大差异。**
- ✓ **The peeling degree was between 2.0 and 6.2, the cooking index was basically stable, and the texture index and taste value of rice kept at a good level. But there are great differences between varieties.**

# 2.4.3 碾磨程度对大米质构特性的影响（客观评价）

## Influence of milling degree on texture characteristics of rice (objective evaluation)

| 品种 var | 碾磨时间(S) Milling time（S） | 硬度（g） Hardness (g) | 粘性（g） Viscidity (g) | 回复性（%） Resilience(%) | 内聚性 Cohesiveness | 弹性（%） Elasticity (%) | 胶黏性 Tackiness | 咀嚼性 Chewiness |
|---|---|---|---|---|---|---|---|---|
| 短粒米 Short grain rice | 0 | 3103.35±312.32 | -9.035±1.23 | 30.19±2.01 | 0.44±0.03 | 49.94±2.63 | 1365.48±70.23 | 681.92±65.35 |
| | 15 | 2070.96±301.03 | -55.26±5.36 | 34.91±2.32 | 0.53±0.08 | 74.03±3.65 | 1097.61±72.04 | 812.56±57.38 |
| | 30 | 2393.11±253.65 | -144.30±11.02 | 39.05±3.20 | 0.57±0.04 | 86.05±4.21 | 1364.07±72.32 | 1173.793±100.32 |
| | 45 | 1994.30±201.01 | -83.49±4.25 | 36.11±2.03 | 0.55±0.05 | 77.99±3.41 | 1096.87±45.65 | 855.45±99.20 |
| | 60 | 2115.23±165.32 | -119.85±5.36 | 36.04±2.22 | 0.55±0.01 | 79.094±2.35 | 1163.38±88.01 | 920.16±86.35 |
| | 75 | 2014.86±186.32 | -124.36±8.25 | 33.98±1.32 | 0.53±0.03 | 83.21±4.23 | 1067.88±74.63 | 888.58±86.35 |
| | 90 | 1725.76±182.32 | -119.95±12.03 | 31.62±2.33 | 0.51±0.02 | 73.98±4.21 | 880.14±82.32 | 651.13±84.63 |
| | 105 | 1703.65±175.32 | -120.01±14.23 | 36.53±3.33 | 0.58±0.03 | 83.56±2.31 | 988.12±75.36 | 825.67±98.63 |
| | 120 | 1700.21±142.36 | -119.68±10.34 | 35.74±4.33 | 0.57±0.04 | 86.32±2.33 | 969.12±67.66 | 836.54±75.32 |
| | 135 | 1702.36±168.98 | -124.32±11.32 | 36.87±5.46 | 0.59±0.03 | 87.32±1.33 | 1004.39±67.66 | 877.04±67.45 |
| 长粒米 Long grain rice | 0 | 1882.76±234.21 | -11.32±0.23 | 25.90±2.12 | 0.43±0.01 | 72.77±3.22 | 809.59±42.35 | 589.14±40.35 |
| | 15 | 1756.55±123.54 | -58.37±1.32 | 31.33±3.56 | 0.49±0.02 | 77.89±3.26 | 860.71±42.36 | 670.41±36.56 |
| | 30 | 1787.10±145.65 | -69.24±1.10 | 34.09±2.45 | 0.53±0.08 | 81.48±3.45 | 947.16±44.21 | 771.75±34.21 |
| | 45 | 1756.51±213.21 | -91.21±1.32 | 34.33±3.54 | 0.54±0.02 | 82.67±2.56 | 948.52±36.56 | 784.14±23.69 |
| | 60 | 1862.42±231.01 | -121.51±12.35 | 35.87±4.35 | 0.55±0.07 | 82.17±4.21 | 1024.33±43.21 | 841.69±23.41 |
| | 75 | 1880.56±121.32 | -101.88±15.21 | 34.70±2.12 | 0.53±0.08 | 80.27±3.45 | 996.70±35.42 | 800.05±52.69 |
| | 90 | 1856.42±213.21 | -101.23±12.32 | 35.21±4.56 | 0.53±0.09 | 82.62±2.65 | 983.90±36.53 | 813.20±40.12 |
| | 105 | 1845.32±201.02 | -102.11±10.23 | 35.62±4.23 | 0.58±0.06 | 83.32±4.86 | 1070.2±56.32 | 891.76±32.14 |
| | 120 | 1798.69±125.36 | -110.32±9.56 | 36.78±3.65 | 0.57±0.04 | 82.98±3.21 | 1025.25±78.98 | 850.76±41.23 |
| | 135 | 1786.36±110.32 | -120.32±11.32 | 37.89±4.78 | 0.59±0.05 | 83.24±3.45 | 1053.95±114.23 | 877.31±45.75 |

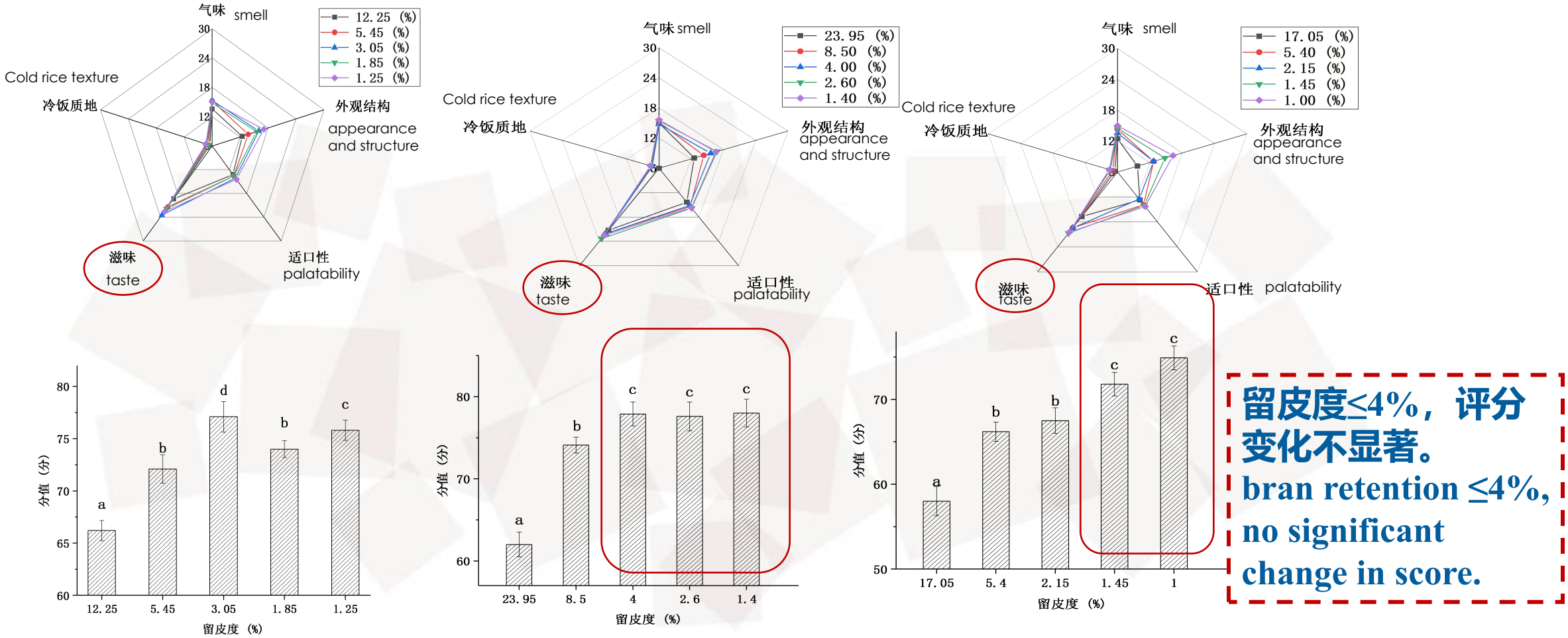
# 2.4.4 碾磨程度对大米蒸煮特性与食味值的影响（客观评价）

## Effects of Milling Degree on Cooking Characteristics and Taste value of Rice (Objective Evaluation)

| 品种Var | 碾磨时间(S) Milling time (S) | 加热吸水率(%) Heating water absorption(%) | 体积膨胀率(%) Volume expansion ratio(%) | 长度延展率(%) Length elongation(%) | 米汤溶出物(mg/g) Rice soup extract(mg/g) | 米汤碘蓝值（A) Length elongation(A) | ph |
|---|---|---|---|---|---|---|---|
| 短粒米 Short grain rice | 0 | 156±12 | 180±4 | 116±4 | 13.03±0.34 | 0.013±0.001 | 6.52 |
| | 15 | 265±8 | 320±4 | 161±3 | 14.45±0.65 | 0.264±0.04 | 6.61 |
| | 30 | 261±3 | 340±7 | 166±4 | 14.51±0.67 | 0.252±0.03 | 6.55 |
| | 45 | 262±4 | 340±7 | 169±3 | 15.33±0.86 | 0.251±0.02 | 6.73 |
| | 60 | 275±1 | 340±4 | 172±2 | 15.94±0.98 | 0.259±0.03 | 6.74 |
| | 75 | 288±4 | 340±5 | 175±4 | 23.74±1.03 | 0.268±0.03 | 6.68 |
| | 90 | 265±5 | 360±3 | 173±2 | 26.08±1.04 | 0.267±0.02 | 6.84 |
| | 105 | 287±4 | 360±4 | 175±4 | 26.29±0.78 | 0.277±0.02 | 6.86 |
| | 120 | 285±4 | 360±4 | 176±8 | 26.31±0.9 | 0.283±0.03 | 6.84 |
| | 135 | 288±4 | 360±4 | 176±3 | 26.3±0.76 | 0.286±0.04 | 6.83 |
| 长粒米 Long grain rice | 0 | 204±8 | 288±4 | 113±4 | 16.57±0.97 | 0.020±0.02 | 6.54 |
| | 15 | 292±4 | 422±2 | 152±2 | 16.07±0.75 | 0.265±0.01 | 6.76 |
| | 30 | 301±5 | 422±3 | 155±5 | 17.57±0.79 | 0.256±0.02 | 6.72 |
| | 45 | 317±3 | 444±4 | 157±4 | 17.60±0.83 | 0.277±0.01 | 6.76 |
| | 60 | 322±4 | 466±2 | 159±6 | 20.22±0.82 | 0.274±0.02 | 6.77 |
| | 75 | 312±3 | 466±1 | 156±3 | 21.96±0.65 | 0.281±0.02 | 6.84 |
| | 90 | 322±2 | 467±4 | 157±2 | 22.01±0.74 | 0.283±0.03 | 6.88 |
| | 105 | 323±3 | 467±7 | 158±7 | 22.01±0.65 | 0.284±0.04 | 6.85 |
| | 120 | 324±2 | 467±4 | 159±4 | 22.19±0.32 | 0.289±0.02 | 6.87 |
| | 135 | 323±3 | 467±4 | 160±4 | 22.15±0.32 | 0.29±0.02 | 6.81 |

# 2.4.5 碾磨程度对大米感官评分和接受度的影响

## Effects of milling degree on sensory score and acceptability of rice

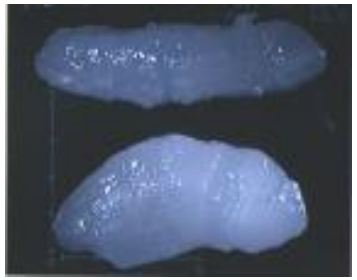



**留皮度≤4%，评分变化不显著。**

**bran retention ≤4%, no significant change in score.**

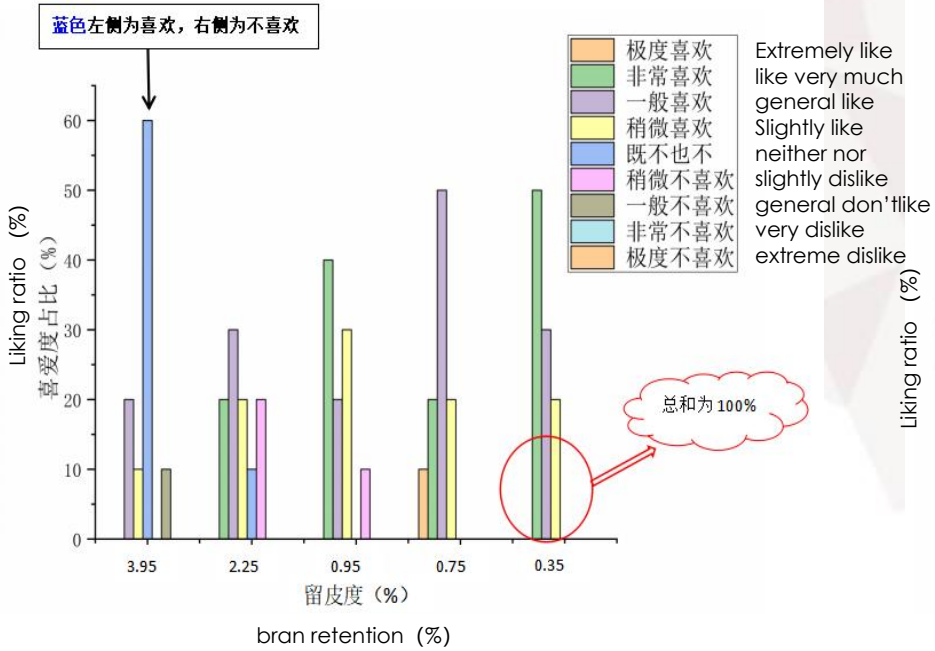
**图11 沙软粘、美香粘和天龙一号不同加工精度（留皮度）大米米饭评分雷达图和感官总评分图**

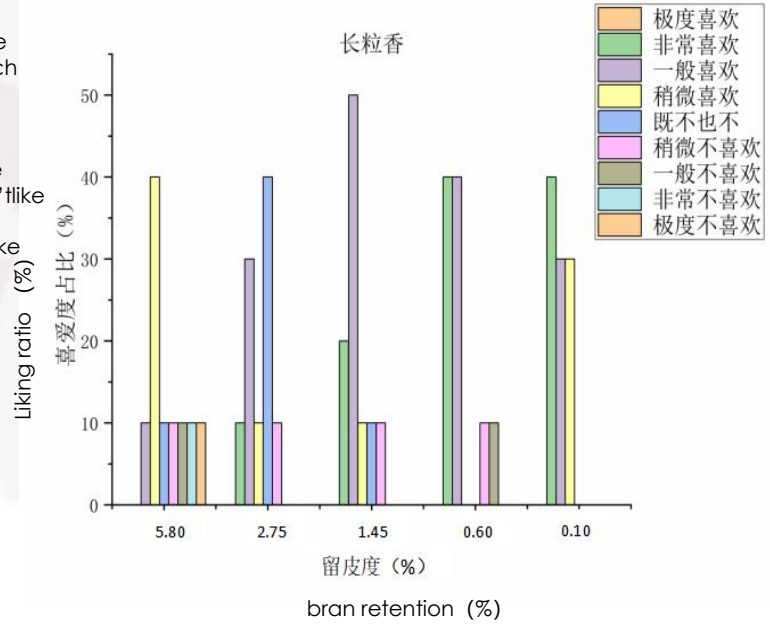
**Figure 11. Radar diagram and sensory total score diagram of rice with different processing accuracy (bran retention) of Sharuanzhan, Meixiangzhan rice and Tianlongyihao rice**

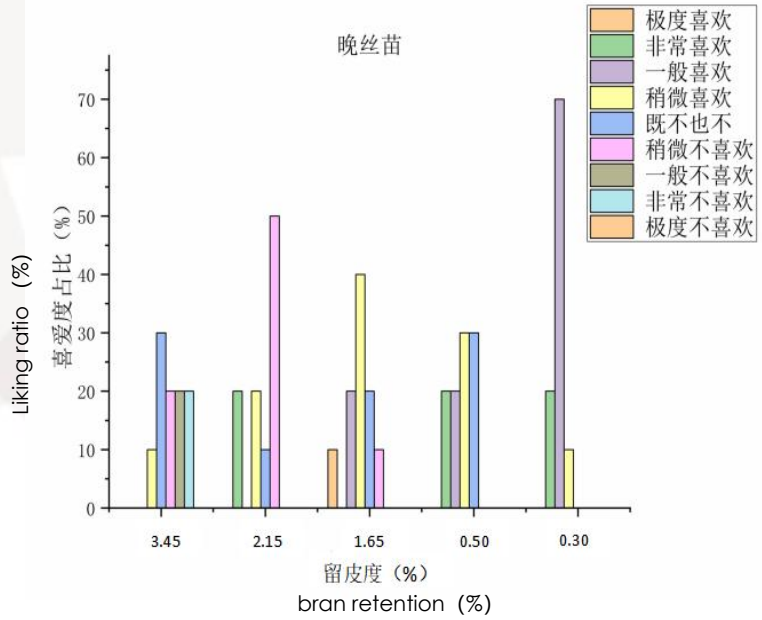


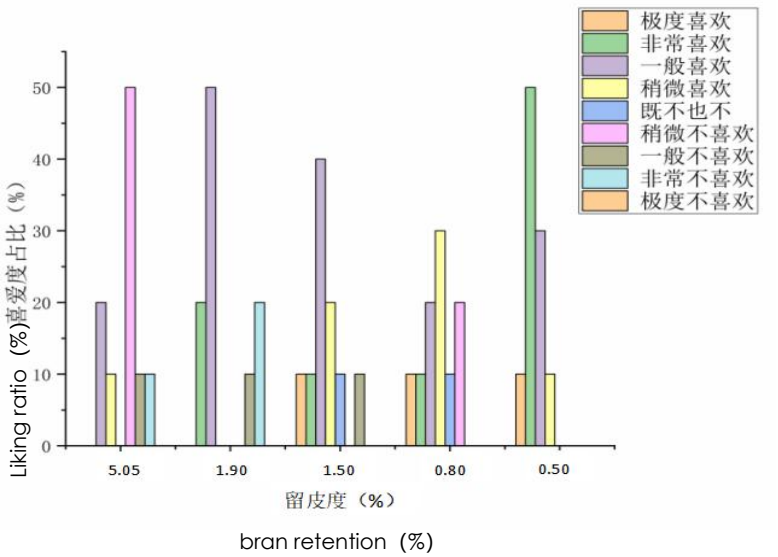
- 轻碾米饭：香味浓郁或清香，颜色正常，结构紧密完整性好。Light rice rice: fragrant or fragrant, normal color, tight structure and good integrity
- 精碾米饭：出现爆花，籽粒不完整，评分低。Refined rice: explosive, incomplete grain, low score

Blue is like on the left and dislike on the right

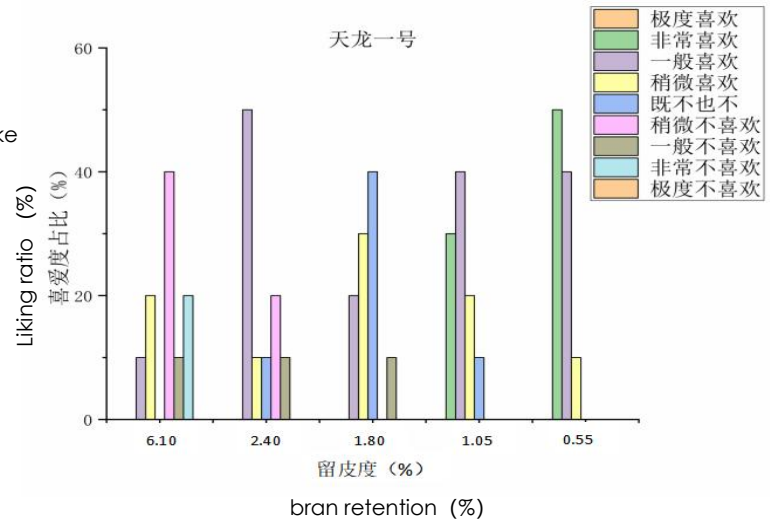


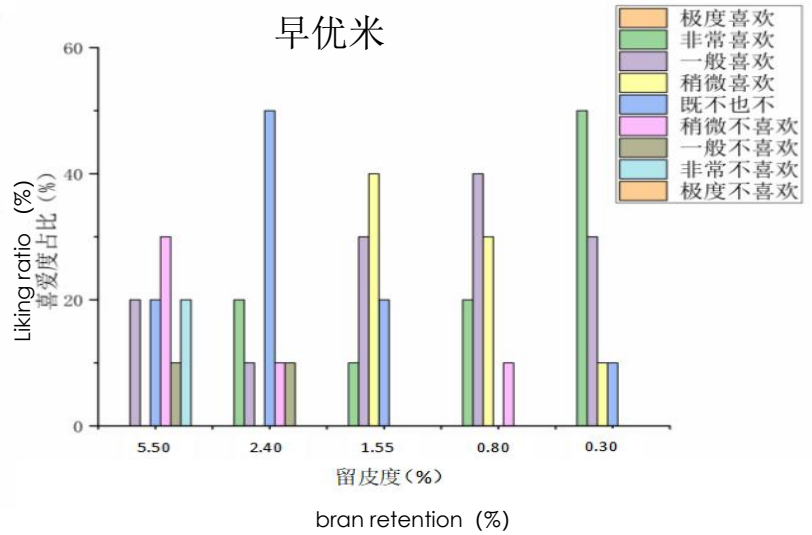






Extremely like
like very much
general like
Slightly like
neither nor
Slightly dislike
general don'tlike
very dislike
extreme dislike




通过感官评价探究不同加工精度大米感官评分和接受程度。评价员对于留皮度在1.90-3.95%范围内的大米，接受度平均在70%以上，最高达90%。另外，最高可有70%的评价员处于不同程度的“喜欢”。

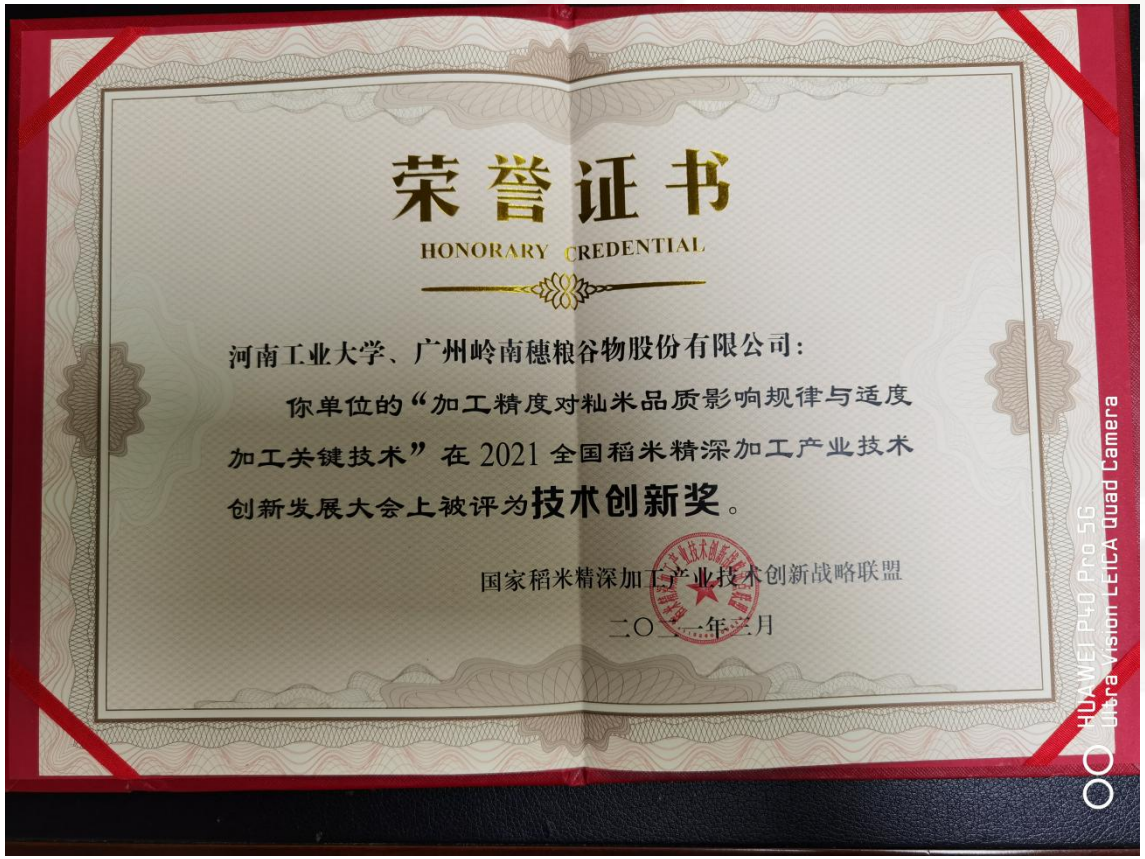
Sensory scores and acceptability of rice with different processing accuracy were investigated by sensory evaluation. For rice with bran retention in the range of 1.90-3.95%, evaluators had an average acceptance of more than 70% and the highest acceptance of 90%. In addition, up to 70% of the reviewers are in some degree of "like".

# 2.5 目前应用情况

与两家企业签订了应用合作协议；广州岭南集团米厂籼米加工三道碾白调整为二道碾白生产适度加工大米，加工粗米出米率为约62~64%，加工精米出米率约为60~62%，电耗一般会节省10~15%，每月销售增加了1000吨左右；辽宁本溪四道碾白三道抛光调整为三道碾白一道抛光，目前还在验证试验。


| 样品 | 留皮度 | 无皮粒数（%） | 留皮<1/5（%） | 整精米数 | 判定结果 |
|---|---|---|---|---|---|
| 原料 | 98.7 | 0 | 0 | 679 | 等外 |
| 一碾 | 23.2 | 5.9 | 62.3 | 644 | 等外 |
| 二碾 | 8.9 | 22.9 | 87.5 | 433 | 等外 |
| 抛光 | 3.3 | 49.3 | 97.3 | 669 | 适碾 |
| 成品 | 2.6 | 52.9 | 98.7 | 711 | 适碾 |

**在日加工400吨籼米生产线上进行了产业化应用，从生产试验结果来看，采用两道碾白可以完全可以达到适度加工大米的需要，总体上从碾磨工段吨米电耗降低了20.36%，出米率提高了5.7%，碎米率降低6.74%。**经过近两年销售，实现红牡丹牌沙软粘粗米、美香粘粗米等12个品种规格2946吨，总销售额1841万元，利润221万元；经过销售，迎合了消费者对营养、健康、美味的需求，受到了用户的欢迎，取得了较好的经济效益和社会效益。





**获得2021年度国家稻米精深加工产业技术创新战略联盟“技术创新奖”**

# Part 3
## Summary

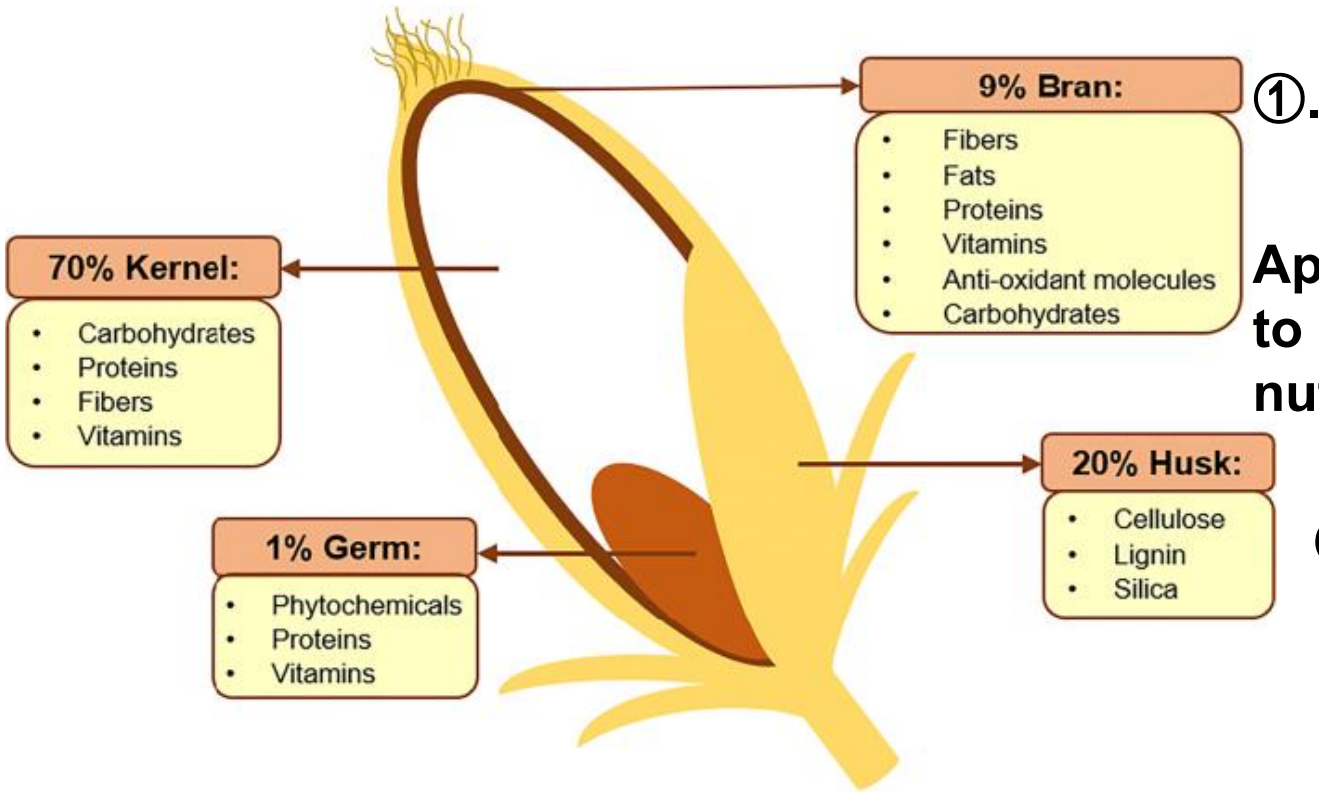



# 3.1 稻谷加工减损技术Technology of Reducing Rice Loss and Waste

②. 精准加工技术：

减少数量损失

Precise processing to reduce the loss of quantity




①. 适度加工技术：

减少营养损失

Appropriate processing to reduce the loss of nutrient

③. 精深加工技术：

减少资源损失

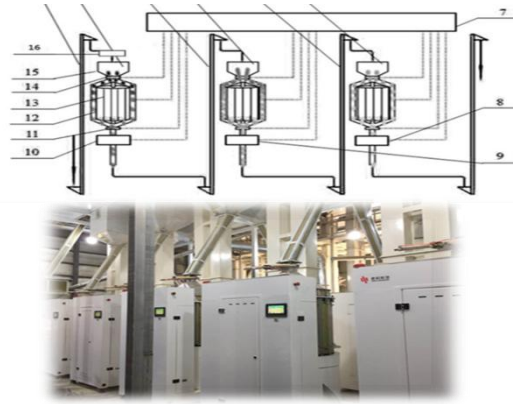
Deep processing to reduce the loss of resource

# 3.1.1 适度加工技术与应用

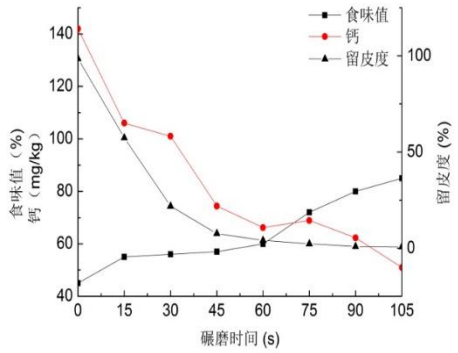
## Appropriate processing technology and its application

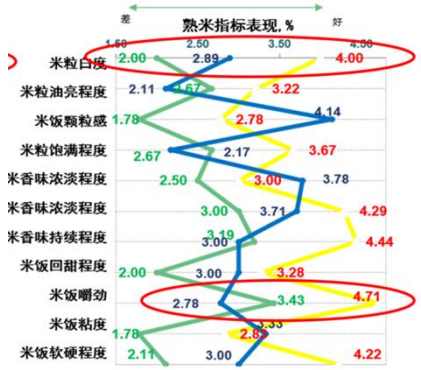
系统研究并确定大米适度的加工精度范围：长粒米留皮度1.90-3.95%，短粒米留皮度2.0-6.2%，其食用品质70%以上接受度；营养成分得到较大程度的保留。

国际首创开发出了加工精度在线检测仪、自动化碾米机组、抛光控制系统，建立了籼米、粳米适度加工示范生产线，解决行业重大需求：降低加工碎米率、爆腰率、电耗三高。



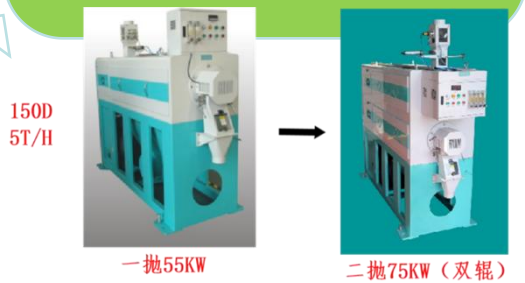
The bran degree is 1.90-3.95% for long rice and 2.0-6.2% for short rice, by appropriate processing technology which caused the reduction of broken kernel and power consumption, and developing on-line detector for milling degree of rice and auto-miller, polisher.




粘米适度加工技术装备及示范

Equipment and demonstration of medium milled indica rice




适度加工对大米品质影响规律

Effect of medium milled on the rice quality

适度加工大米品质评价体系与加工技术规范

Quality evaluation system and technical criterion of medium milled rice

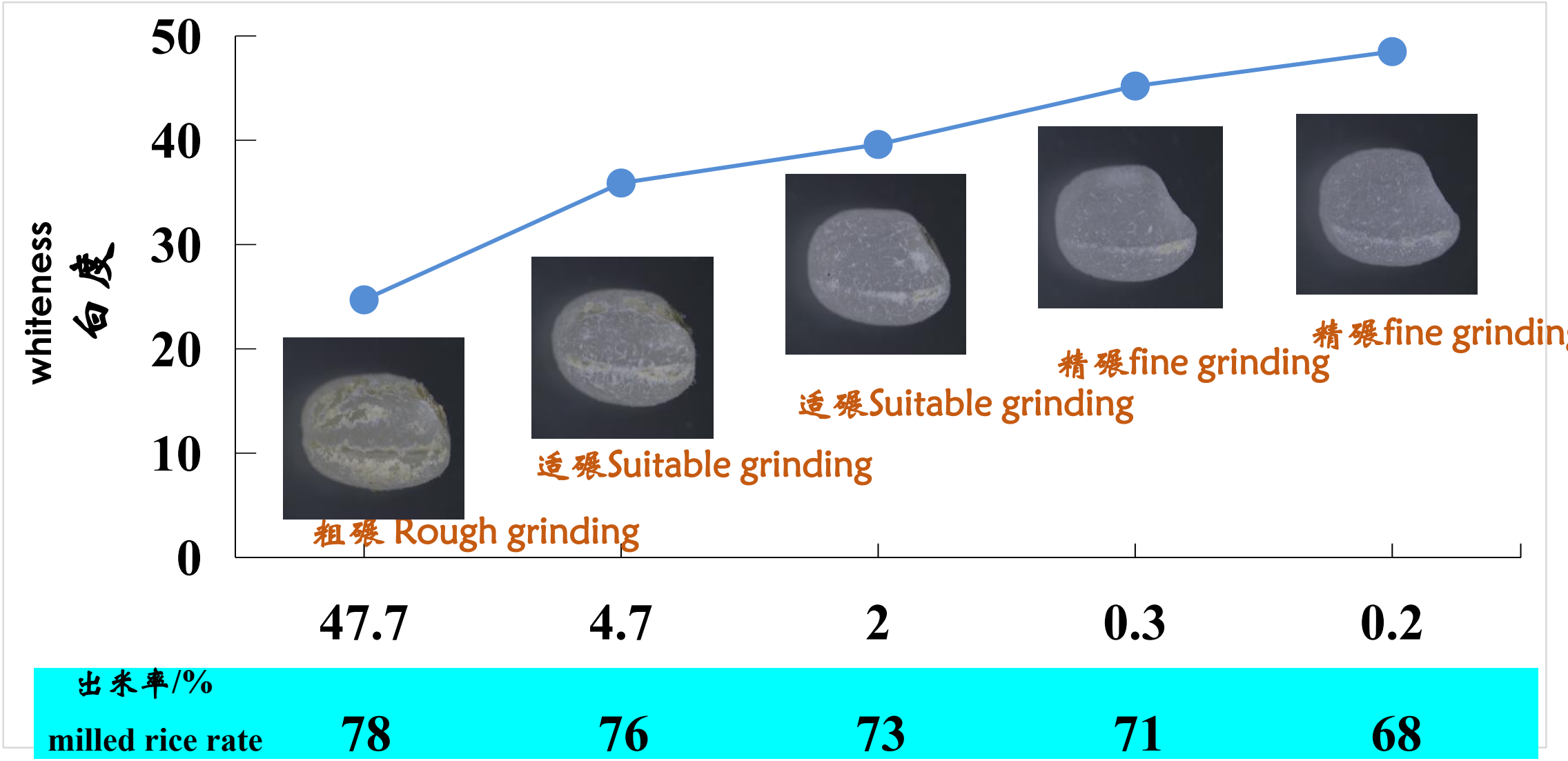
适度加工大米在线检测仪

On-line detector for medium milled rice

粳米适度加工技术装备及示范

Equipment and demonstration of medium milled japonica rice

# •适度=减损、节能、营养 Moderate = Derogation, Energy conevation, Nutritious

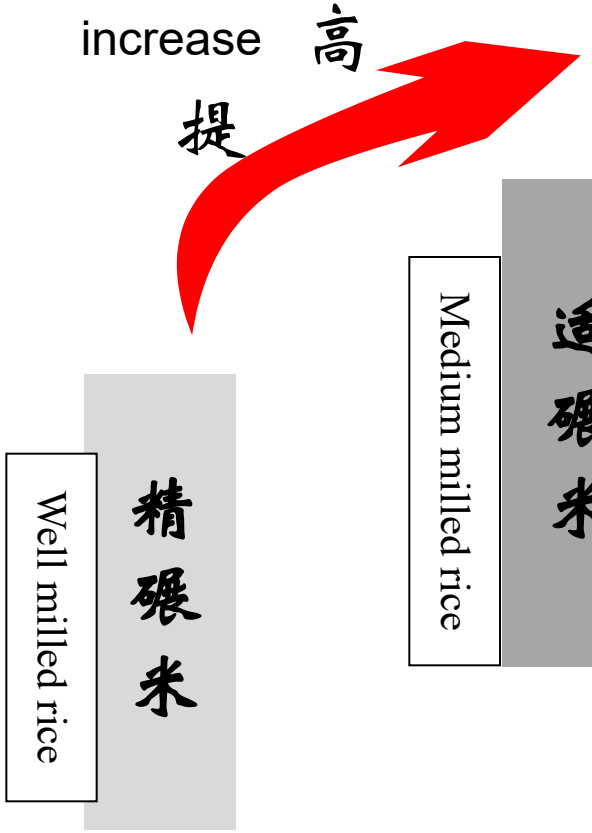



| | | | | | |
|---|---|---|---|---|---|
| | 47.7 | 4.7 | 2 | 0.3 | 0.2 |
| 出米率/% milled rice rate | 78 | 76 | 73 | 71 | 68 |

出米率可以提高3.2%，中国稻谷加工量2.0亿吨左右，相当于多出640万吨大米，按照稻谷出米率70%，6.4吨稻谷/公顷的产量计算，相当于2150万亩稻田的产量，对节约耕地和保障粮食安全具有重要意义。

A 3.2 % increase in rice production would equate to 6.4 million tons more rice being processed in China. According to the rice producing rate of 70% and the yield of 6.4 tons of rice per hectare, it is equivalent to the yield of 21.5 million mu of rice field, which is of great significance to saving farmland and ensuring food security

# 适度=营养 Moderate = Nutrition




脂　肪fat：60 %-277 %

膳食纤维：41 %-229 %

dietary fiber

Vitamin $B_1$：1 %-7 %

Vitamin $B_2$：58 %-202 %

镁Magnesium：5 %-30 %

钾Potassium：52 %-174 %

磷Phosphorus：25 %-78 %

钙 Calcium ：28 %-91 %

✓ 供能，保护内脏，参与机体代谢。

Provide energy, protect viscera, participate in body metabolism.

✓ 促进肠道蠕动，改善便秘，降低患结直肠癌和肥胖症的风险。

Improves bowel motility, improves constipation and reduces the risk of colorectal cancer and obesity.

✓ 维生素B族对皮肤黏膜、神经系统及心脏等有重要生理作用。

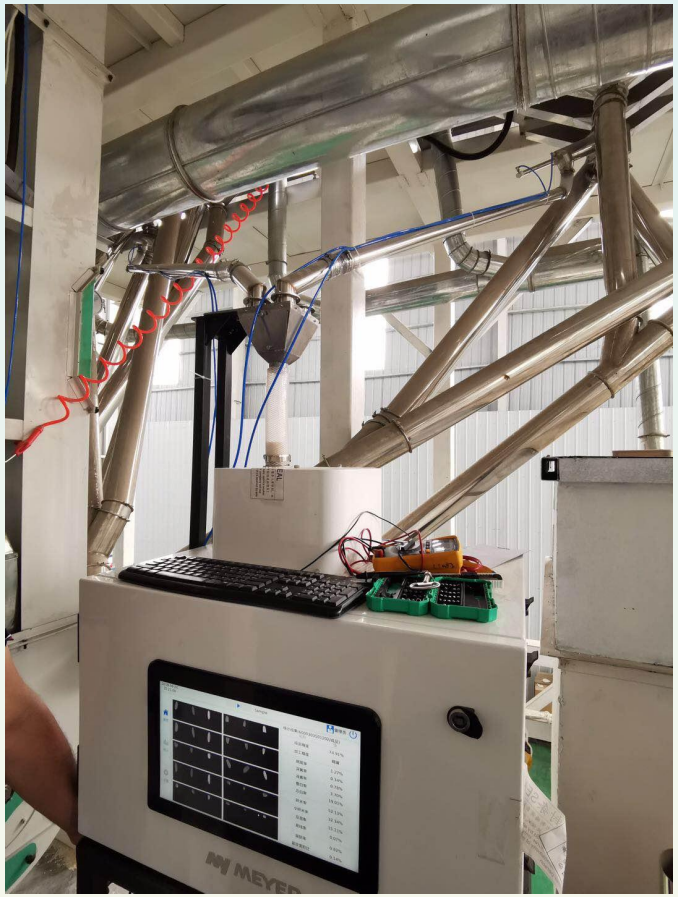
Vitamin B group has important physiolo gical effect to bran mucous membrane , nervous system and heart.

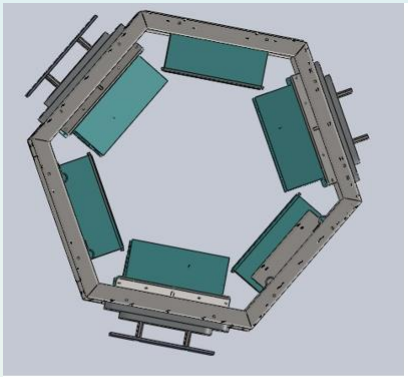
✓ 矿物质元素可维持心脏正常功能。

Minerals help maintain the normal functioning of the heart.

# 大米加工精度在线监测技术及装备On-line monitoring technology and equipment for milling degree of rice

米皮、米胚识别率达到90%，为自动化适度加工大米生产线提供了关键装备。The recognition rate of rice bran and embryo reached 90% and the company supply  the equipment for rice producing line to control the moderate processing automatically.

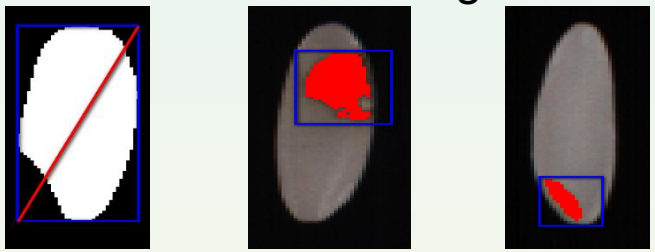




多视角、高分辨图像获取技术

Multi - view, high - resolution image acquisition technology

Shape recognition, color recognition, texture location real-time recognition algorithm



形状识别+ 颜色识别+ 纹理位置实时识别算法

Application Certification

应用证明

| | | | |
|---|---|---|---|
| 项目名称 | 大宗米制品适度加工关键技术装备研发及示范 | | |
| 成果名称 | 大米全景品质检测仪 | | |
| 应用单位 | 合肥市韩氏粮食机械设备有限公司 | | |
| 应用联系人 | 王总 | 联系电话 | 15855100466 |
| 应用起止时间 | 2019 年 6 月至今 | | |
| 应用情况 | 合肥美亚光电技术股份有限公司自主研制的全景品质检测仪，于 2019 年 6 月在我公司大米加工产线上开展应用。<br>全景品质检测仪能在线准确检测出加工米样的加工精度，平台上留胚识别率约 90%，留皮识别率约 90%，可用于指导生产线协同加工参数调节。该设备和大米色选机的智慧互联，可以精准检测出大米色选机进出料的含杂比例，用于指导大米色选机的色选参数调节。该设备可定期对加工米样含杂分类汇总，方便我司掌握产线的总体加工情况，用于指导产线加工调整。特别地，大米加工精度的在线监测，保障了出厂大米能够满足国标精度要求。<br>全景品质检测仪在线运行稳定好，数据测试准确高，是一款可全面推广的商业化产品。希望美亚光电继续坚持技术创新，向社会提供更好的产品与服务。 | | |
| 声明 | 我单位保证上述提供的应用情况真实无误，如有不符，本单位愿意承担相关后果并接受相应的处理。<br>应用单位（盖章）：合肥市韩氏粮食机械设备有限公司<br>2019 年 8 月 10 日 | | |

在线一机多用应用试验On-line multi-purpose application test

首页

统计

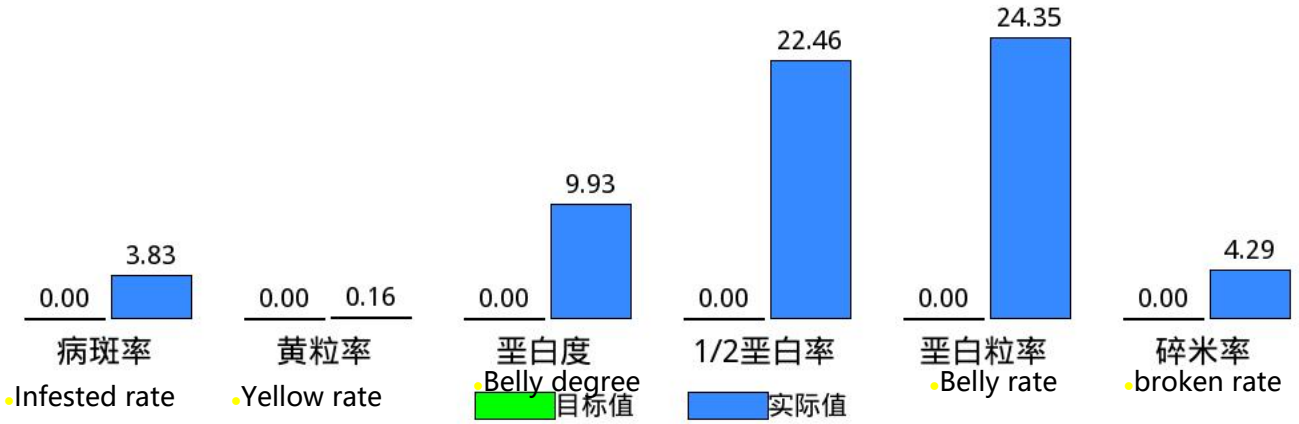
设置

目标方案 | 实时数据 | 历史图像

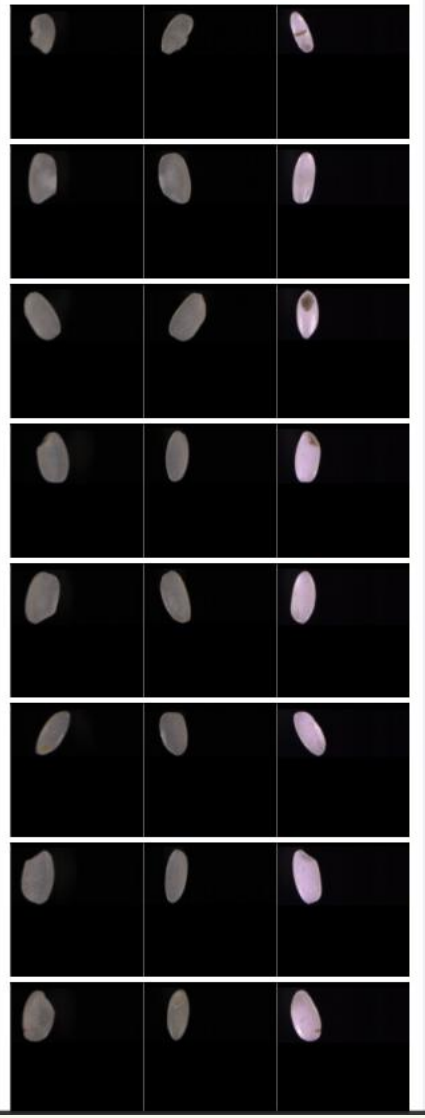
联机控制 OFF

# Real-time data

含杂数据(%)




图片

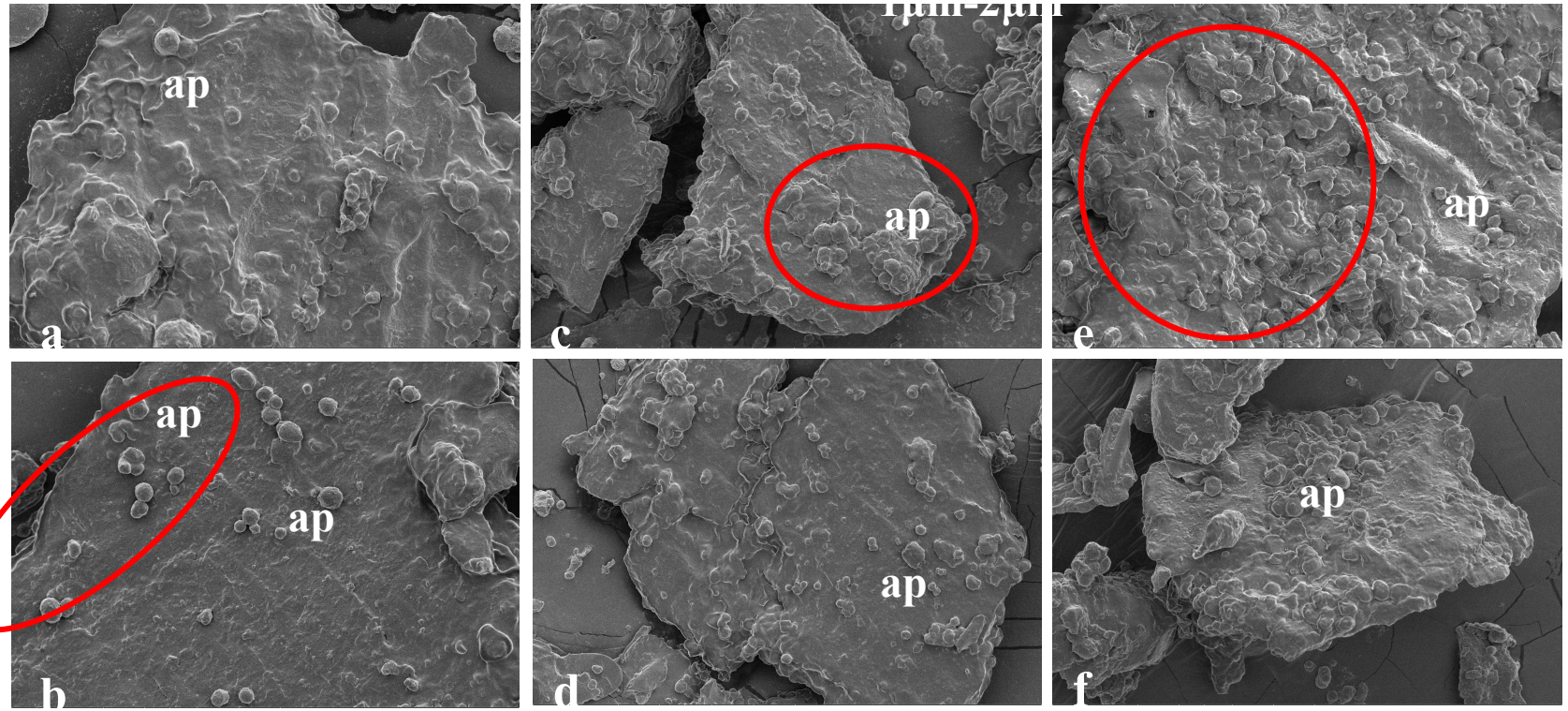


统计结果(6000304001296/成品)

| 名称 | 实际值 |
|---|---|
| Rice grad 大米等级 | 三级 |
| milling degree 加工精度 | 精碾 |
| 病斑率 | 3.83% |
| Yellow rate 黄粒率 | 0.16% |
| 垩白度 | 9.93% |
| 1/2垩白率 | 22.46% |
| Belly rate 垩白粒率 | 24.35% |
| broken rate 碎米率 | 4.29% |
| 小碎米率 | 0.06% |
| 留皮度 | 0.73% |
| 互混率 | 23.61% |
| 长宽比 | 1.79 |
| 背线率 | 1.89% |
| 留胚率 germ rate | 27.65% |

# 3. 2. 精准加工技术与应用

## Roughening Degree砂辊开糙程度的确定




| roughening 20s<br>开糙20s<br>DOM2.89%、bran degree 67.5%<br>DOM2.89%、留皮度67.5% | roughening 40s<br>开糙40s<br>DOM5.81%、bran degree 23.2%<br>DOM5.81%、留皮度23.2% | roughening 60s<br>开糙60s<br>DOM6.19%、bran degree 8.3%<br>DOM6.19%、留皮度8.3% |
|---|---|---|

**Fig.1 SEM images of rice bran with different roughness（ap：protein）**
**图1 不同开糙程度米糠扫描电镜图像（ap：蛋白质体）**

With the extension of roughening time, more and more protein bodies were stripped from endosperm. After the loss of proteome, the interaction between protein and starch will be weakened, which is more likely to cause endosperm damage.随开糙时间延长，越来越多的蛋白质体从胚乳中剥离。失去蛋白质体后，蛋白质和淀粉之间的相互作用会因此而减弱，更易造成胚乳损伤。

# Roughening Degree
# 砂辊开糙程度的确定

## Table.3 Stereomicroscope of rice with different roughness after dyeing
## 表3 不同开糙程度大米经染色后体视显微镜图像

The cortex is blue-green and endosperm is purplish red。皮层呈蓝绿色

| | | | | |
|---|---|---|---|---|
| DOM（碾减率） | 1.75%-2.21% | 2.89%-3.36% | 4.38%-4.49% | 5.81%-6.17% |
| Bran degree 留皮度 | 90.0%-95.4% | 67.5%-79.4% | 42.1%-52.0% | 22.7%-27.9% |
| | 开糙 10s | 开糙 20s | 开糙 30s | 开糙 40s |
| 原阳新丰 2 号 | | | | |
| 本溪辽粳 | | | | |
| 吉林超级稻 | | | | |

There is bran in the dorsal sulcus, and the residual cortex is more than 2 / 3
背沟有皮，皮层残留大于三分之二

The dorsal sulcus has bran and is linear. Cortical residue greater than half
背沟有皮，呈线状、皮层残留大于二分之一

The dorsal sulcus has bran and is linear. Cortical residue is less than half
背沟有皮，呈线状，皮层残留小于二分之一

The dorsal sulcus has bran and does not form a line
背沟有皮不成线

**The roughening time is 10 s-40 s, which can achieve the purpose of roughening.**
**开糙时间为10 s-40 s 可达到开糙目的。**

Incomplete roughening
未开糙完全

Complete Roughening

Complete Roughening

Complete Roughening

# 3. 2. 精准加工技术与应用

## Precise processing technology and its application

国际首创采用光电分选的回砻谷净化技术，精准分离回砻谷中的糙米。

It is the first international initiative to adopt photoelectric separation purification technology to accurately separate brown rice from rehubrang paddy.

回砻谷净化技术与原技术生产情况对比

Comparison between photoelectric purification technology and original technology

| 名称name | 回砻谷含糙ratio of brown rice in rehubrang paddy /% | 爆腰率crack ratio /% | 糙碎ratio of broken brown rice /% |
|---|---|---|---|
| 回砻谷净化技术 | ＜3.5 | 4.0~6.0 | 2.68~2.71 |
| 原技术 | ＞70 | 8.0~11.0 | 4.85~5.35 |
| 差值/百分点 | -66.5 | -4.0~5.0 | -2.06~2.17 |

Before purification

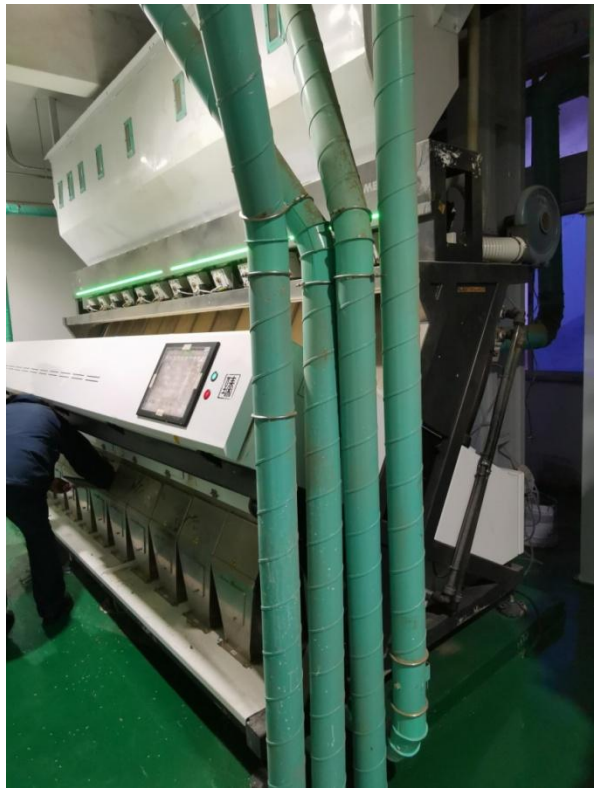
← 回砻谷净化前

回砻谷净化后→

After purification

回砻谷净化设备

Equipment to separate brown rice from rehubrang paddy



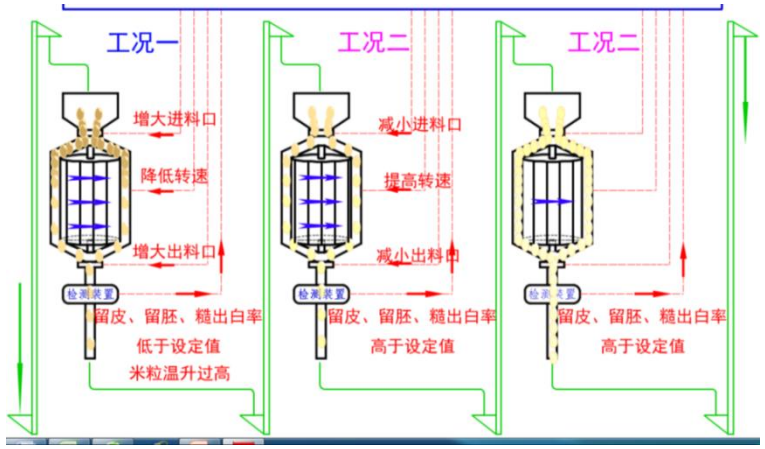
# 3. 3. 精准加工技术与应用

## Precise processing technology and its application

国际首创自动碾米机+在线检测+智能控制系统示范线。

The first production line of automatic rice milling machine, online detection, and intelligent control system in the world.

设定留皮度后，自动在线检测生产线大米的留皮度（加工精度），实时反馈控制自动化碾米机，构成智能化、自动化精准控制籼米适度加工系统，精准达到设定的大米产品留皮度。




智能控制系统示意图

在线检测仪

自动碾米机

新系统与原设备生产情况对比

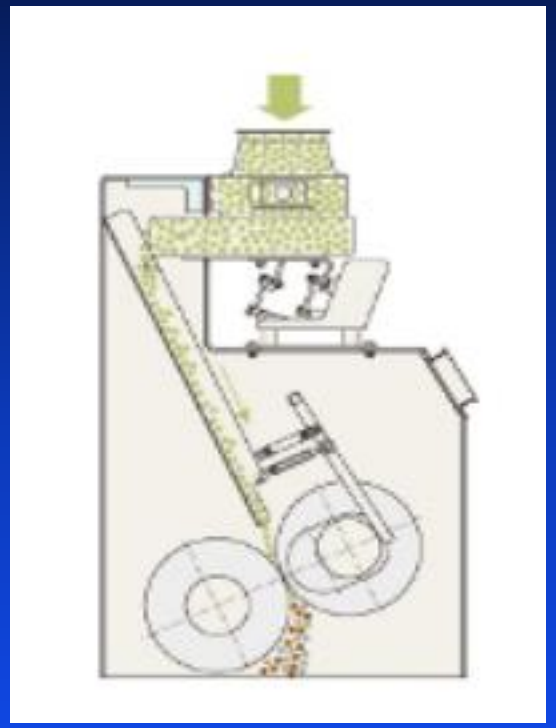
Comparison of the new system with the original equipment

| 名称 | 留皮度及波动度 bran degree/% | 碎米率 broken rice ratio/% | 碾米机单位电耗 power consumption per unit/（kWh/t） |
|---|---|---|---|
| NEW新系统 | 3.35±0.35 | 4.0~6.0 | 9.0 |
| OLD原设备 | 2.9±2.6 | 8.0~16.0 | 19.0 |
| 差值/百分点 | 波动范围-2.25 | -4.0~10.0 | -10.0 |

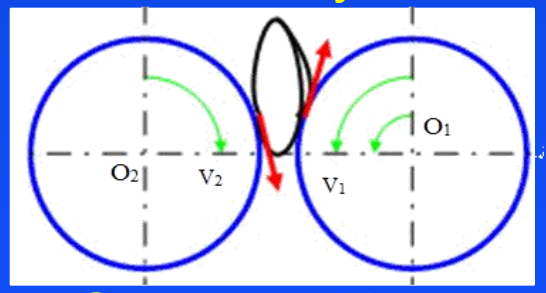
# 胶辊砻谷机的双变频电机驱动技术创新

# Revolutionary rubber roll paddy rice hulling machine

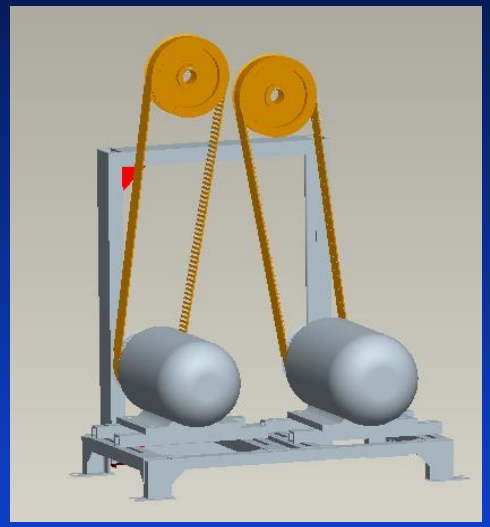
**VF and PLC**
controled motors
for rolls drive system

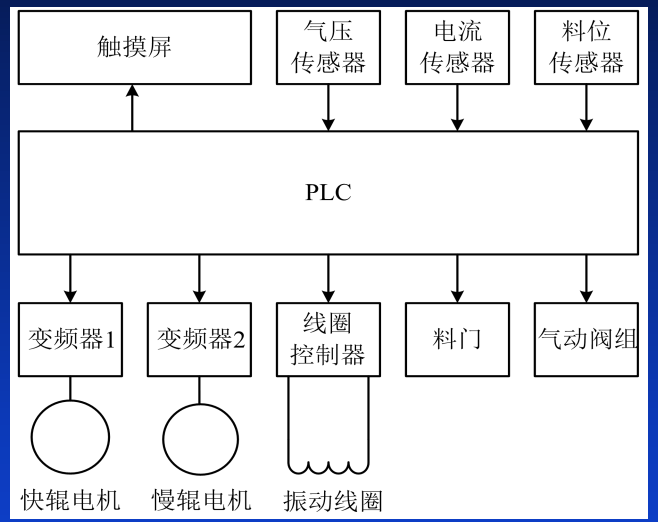


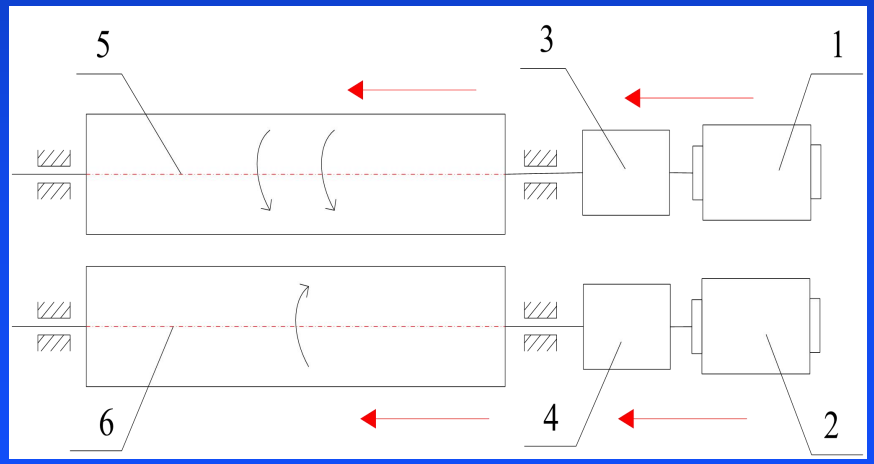
Paddy




Slow Fast






# 双变频电机驱动砻谷机的创新特点与应用效果

## Design features and application benefits in rice mills with the Revolutionary Rubber Roll Huller

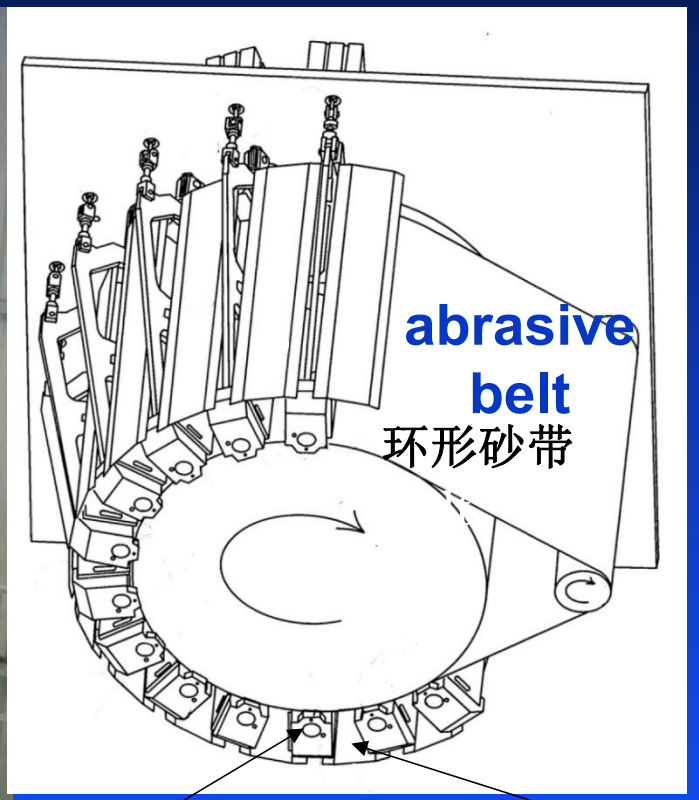
- VF and PLC controled motors for the rollers drive system.变频和 PLC控制
- Variable roll speed and differential as needed and automatically with no downtime.
- Possible to make the front or back roll the fast roll. 快辊慢辊变换
- When engaged, during the hulling phase, the slow motor generates an electric current toward the drive circuit, where it is directly used by the fast motor; this immediately reduces the electrical network power absorption, obtaining:

- **ENERGY SAVING 30% 节能30%。**
- **Improved hulling efficiency 提高脱壳率。**
- **Minimum breakage / maximum yield 减少破碎，提高产量。**
- **Short downtime 检修时间少。**
- **Longer lifetime of rubber rollers (15%) 延长胶辊寿命15%**
- **High throughput capacity (up to 12 t/h).高产能12吨/小时。**

# 创新型砂带碾米机
# Revolutionary abrasive belt rice whitening machine

Rice whitening gently achieved






white rice

bran

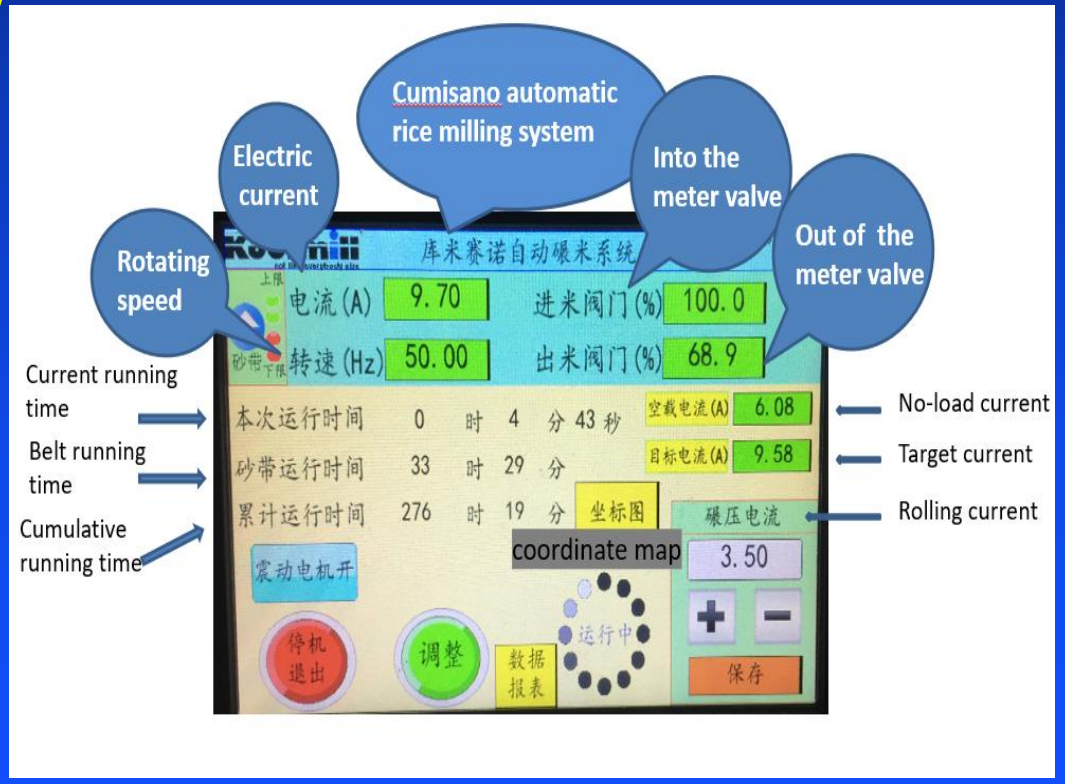
# 创新型砂带碾米机的创新特点与应用效果

## Design features and application benefits in rice mills with the Revolutionary Abrasive Belt Rice Whitener

Rice whitening is gently achieved with the abrasive belt. **Low** energy consumption, **low** breakage and **low** temperature rise for the whitening process:

- 破碎率降低 8% lower breakage / maximum yield
- 电耗降低 15 kWh/t lower energy consumption
- 温升降低 13℃ lower temperature rise

Cool rice whitening line 100 t/d



# Producing line 1：Guizhou province Maogong miller湄潭

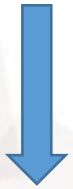

# 截止目前示范线情况一览

# Overview of the production demonstration by now

| | 库米赛诺碾米生产线<br>Koolmill milling production line<br>（新线 new） | | | | 原生产线<br>The primary production line<br>（老线 old） | | **库米赛诺<br>新线优势**<br>The advantage of the new production line | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 示范线<br>Producing line | 累计<br>加工稻谷<br>（吨）<br>Total paddy(ton) | 累计标米<br>（吨）<br>Total milled rice (ton) | 平均<br>增碎率<br>Average breakage rate | 单位能耗（kWh/吨）<br>Unit energy consumption (kWh/ton) | 增碎率<br>Breakage rate | 单位能耗（kWh/吨）<br>Unit energy consumption (kWh/ton) | 降碎<br>幅度<br>Reduced breakage | 节能幅度<br>（kWh/吨）<br>Energy saving rate | 总计增效<br>（万元）<br>Increased benefit (￥10000) | 平均<br>吨米增效<br>（元/吨）<br>Average increased benefit per tons of rice (￥/ton) |
| 河南淮滨<br>Henan Huaibin | 2450.5 | 1622.70 | 2.8% | 11.82 | 11.0% | 22.00 | 8.2% | 10.00 | 51.18 | 157.70 |
| 广西宾阳<br>Guangxi Binyang | 1750.0 | 1082.10 | 2.5% | 10.12 | 10.0% | 22.00 | 7.5% | 12.00 | 50.78 | 234.60 |
| 湖北禾丰<br>Hubei Hefeng | 1887.8 | 1243.50 | 2.6% | 11.94 | 11.0% | 22.00 | 8.0% | 10.00 | 37.36 | 150.24 |

过度加工＝好看&好吃&浪费&耗能

Over processing ＝ Good looking&Delicious&Energy consuming



适度加工＝好吃&营养&节约 &节能

Over processing ＝Delicious&Nutritious&Economically&Eenergy conservation

精准加工 ＝好吃&营养&科学&节能

Precision processing＝Delicious&Nutritious&Scientific&Eenergy conservation

# 3.4 精深加工技术与应用
## Deep processing technology and its application

米火腿人造肉Rice-TVP Ham

膨化米饼Rice Cookie

蛋糕Tteok Cake


大米蛋糕专用粉
Rice flour for pancake

多用途米制品专用粉
Gluten-free all purpose rice flour

年糕Tteok

大米饼干Rice cookie

大米面包Rice Bread

大米乌冬面Rice Noodle

# Thank you very much for your attention!