TBIG
Thailand Beer Industry Guild
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Challenges and Opportunities for the Brewing Industry in South-East Asia
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VLB BERLIN

# QUALITY PARAMETERS OF RICE USED FOR ADJUNCT BREWING

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# Content

1. Overview of rice varieties
2. Why use rice in brewing
3. Rice production & processing
4. Rice classification
5. Amylose content evaluation
6. RVA (Rapid Viscosity Analyser)
7. Shelf life evaluation method
8. Conclusion
9. Q&A

# Rice Varieties


*Figure1. Rice varieties*

# Rice Varieties


*Figure2. Rice varieties (cont.)*

# WHY USE RICE In Brewing?

## *Cost-, Quality- and Emotional Aspects*

# World Rice Production



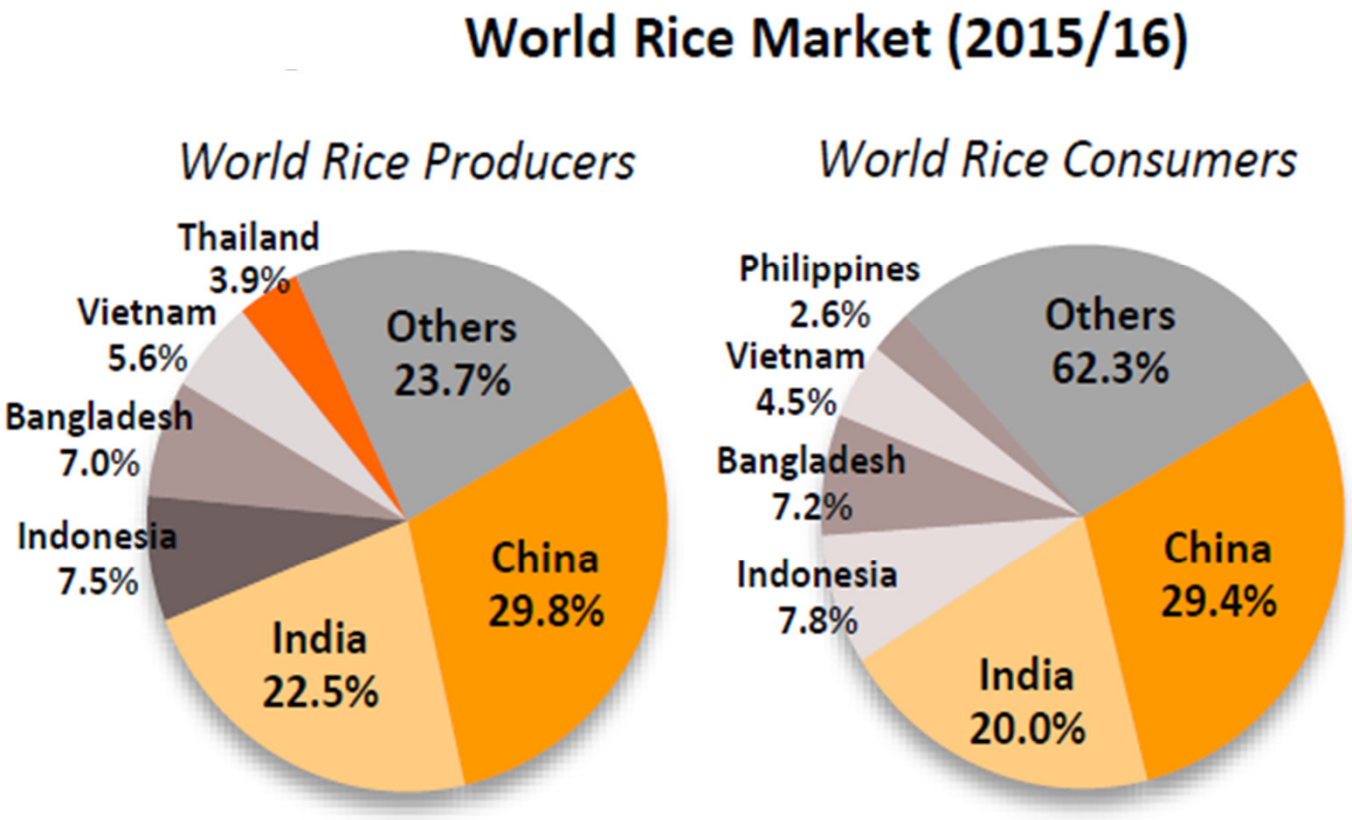



*Figure3. World Rice Market(2015/16). Chetchuda Chausuwan,2018*

# World Rice Export

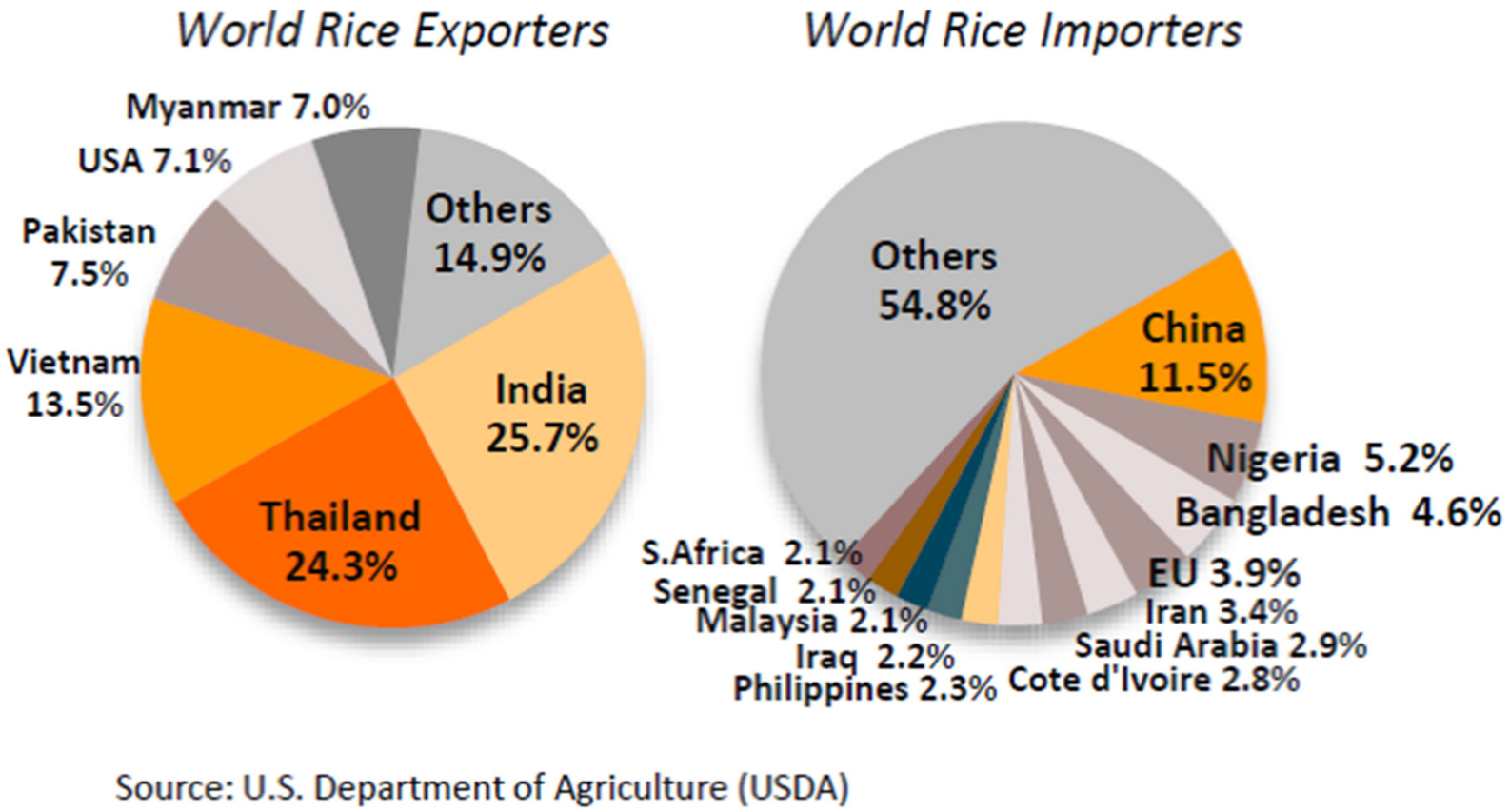



*Figure 4. World Rice Export (2015/16).Chetchuda Chausuwan,2018*

# Rice Advantages

- Higher extract content compared to barley
- Sodium and cholesterol-free.
- Nutrient content: containing more than 15 vitamins and minerals, including B-vitamins, iron, zinc, thiamin and folic acid.
- Only minor fat content; no saturated fat or trans fatty acids.
- Complex carbohydrate composition
- Rice is the least allergenic of all grains and naturally gluten-free

# Rice Composition

*Table 1. Cereal composition*

| Food | Moisture (%) | Protein (g N*6.25) | Crude Fat(g) | Carbohydrate | Fiber (g) | Crude Ash(g) | Energy Calories |
|---|---|---|---|---|---|---|---|
| Rice | 14 | 7.3 | 2.2 | 71.1 | 4.0 | 1.4 | 1610 |
| Wheat | 14 | 10.6 | 1.9 | 61.6 | 10.5 | 1.4 | 1570 |
| Barley | 14 | 9.8 | 4.9 | 60.9 | 9.0 | 1.4 | 1660 |
| Maize | 14 | 8.3 | 3.9 | 57.4 | 13.8 | 2.6 | 1610 |
| Sorghum | 77 | 2 | 0.1 | 15.4 | 2.5 | 2.3 | 294 |
| Potato | 63 | 1 | 0.2 | 31.9 | 2.9 | 1.0 | 569 |

*Souci SW, Facmann W, Kraut H (1986) Food composition and Nutrition Table 1986/87, Wissenschaftliche Verlagsgesellschaft, Stuttgart.*

# Rice Processing

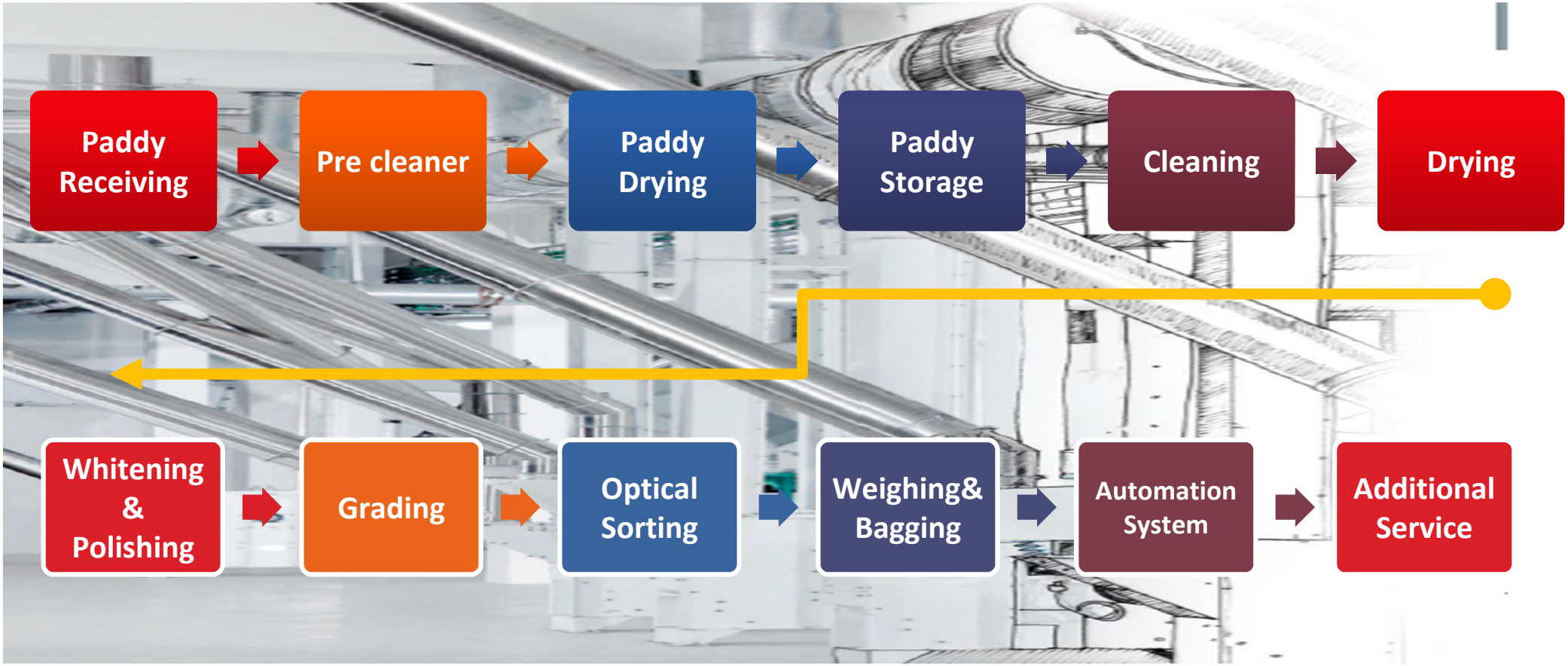



*Figure 5. White Rice Processing*

# Thai Rice Classification

## Categorized Rice by: TAS

- **Degree of Milling**
- **Kernel Size**
- **Starch Content**

***Referent :Thai Agricultural Standard TS 4004 - 2017***

# Rice Group: Degree of Milling

**Paddy Rice** or **Rough Rice** is completely unprocessed.
It includes the hull and is indigestible.

**Whole Grain (Brown) Rice** has the hull removed, leaving the bran layer and germ intact.

**White Rice** is the endosperm of the kernel with the hull, bran, and germ removed.

# Rice: Starch Content

Starch makes up most of a rice kernel. Rice is composed of two types of starch molecules:

- **Amylose**
  - Makes rice firm and fluffy
  - Good for pilafs, entrees, salads
- **Amylopectin**
  - Makes rice soft and sticky
  - Good for risotto, sushi, desserts

**Amylose:**
- α-1,4 glycosidic bond (~100%)
- 10–30% typical composition


**Amylopectin:**
- α-1,4 glycosidic bond (94–95%)
- α-1,6 glycosidic bond (5–6%)
- 70–90% typical composition

# Rice Group: Starch Content

**Rice Group: 4 Groups**

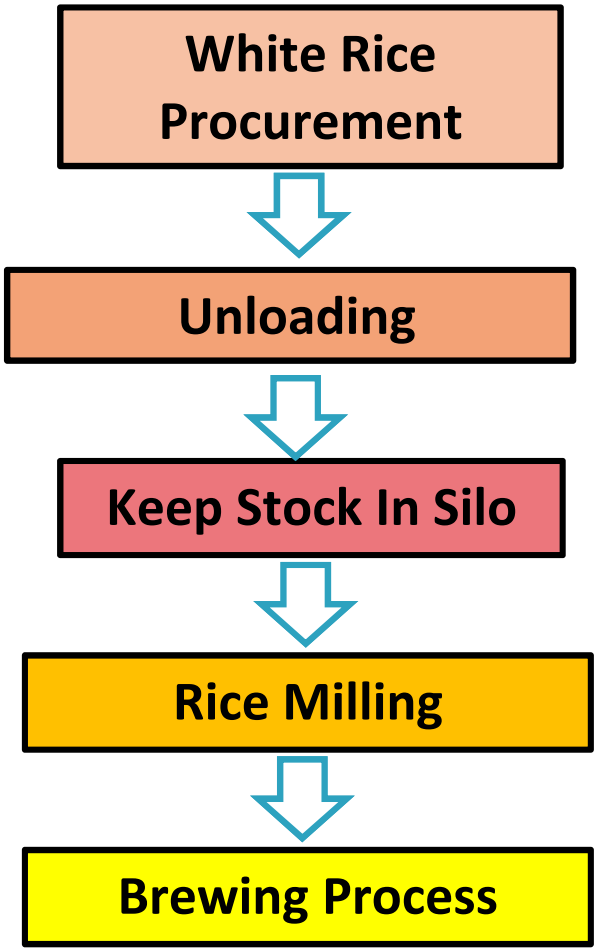
- ❑ **Low Amylose Rice (13-20%)**
- ❑ **Medium Amylose (20-25%)**
- ❑ **High Amylose ( >25%)**
- ❑ **Sticky Rice(Glutinous Rice)**

***Referent :Thai Agricultural Standard TS 4004 - 2012***

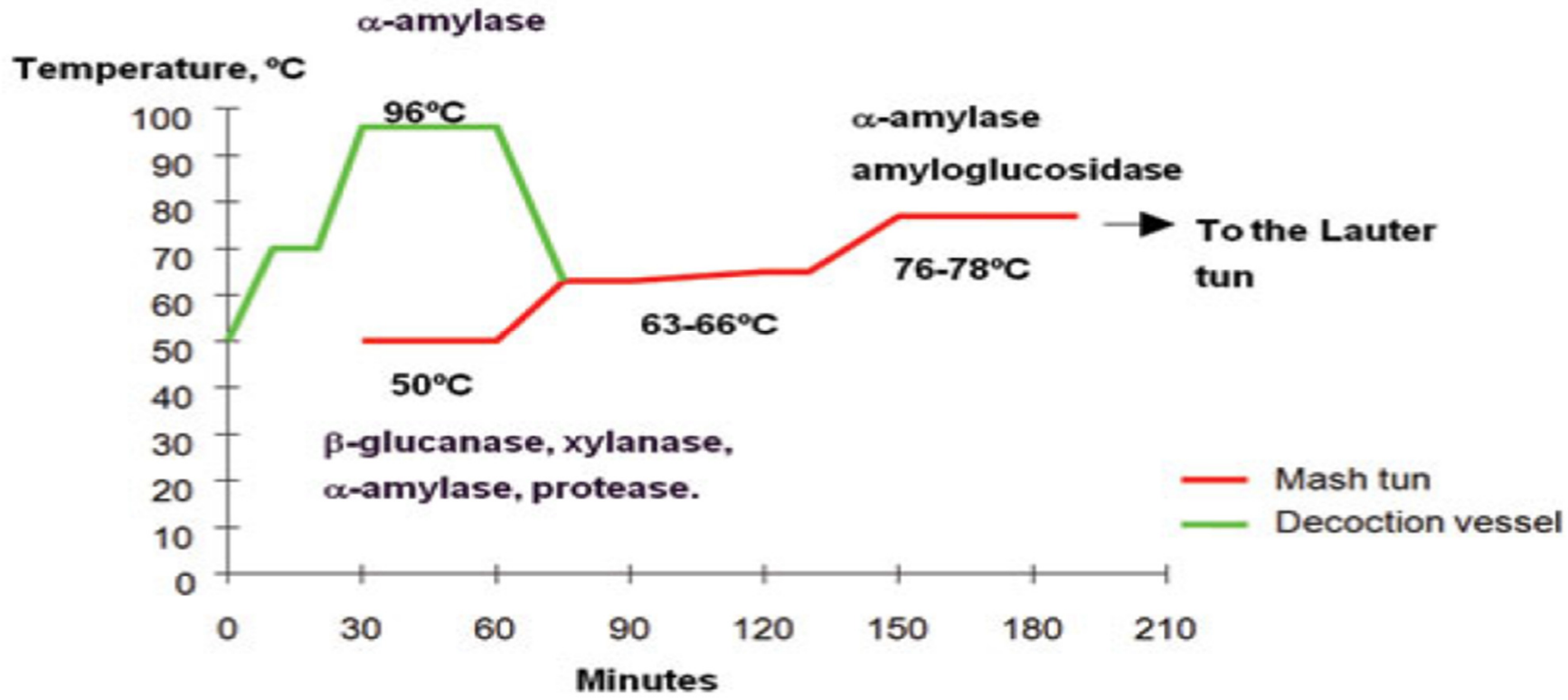
# White Rice Brewing Handling

## Brewing Applications

- ✓ Use an adjunct cooker (Temp.> 100 oC)
- ✓ Mash rice with 10-20 % of the malt mash and hold at 78 oC
- ✓ Some Rice varieties that do not gelatinize below 80 oC must be heated to 85 -90 oC to gelatinize and then cooled to 70 – 75 oC for sacharification
- ✓ Rice malt used as barley malt
- ✓ Gelatinized with amylase
- ✓ Etc.



# White Rice Brewing Process




A typical double mashing system's time and temperature regime

*Figure 6. Mashing program of cereal cooking*

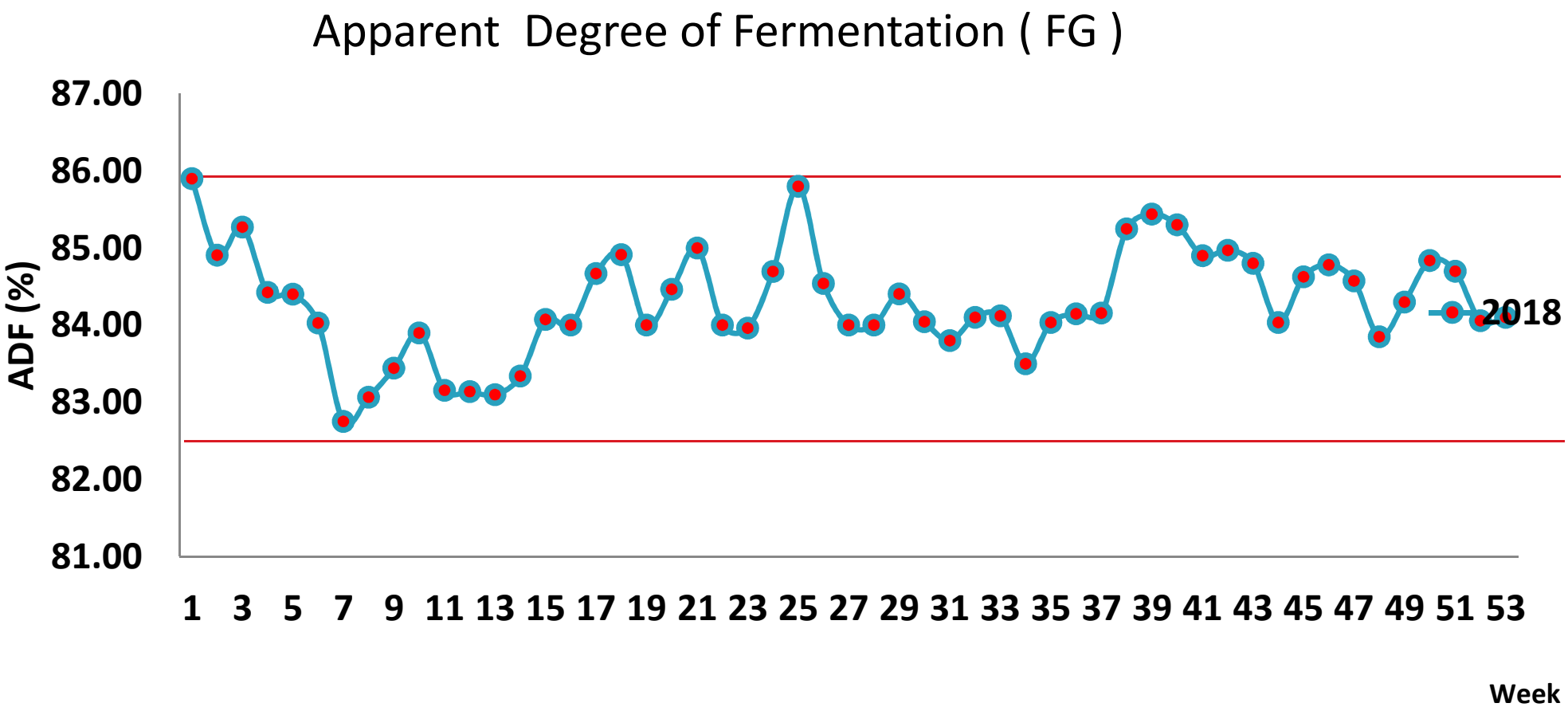
# Brewing Process

- What is **Attenuation** in Brewing
  - A measure of the degree to which sugar in wort can be fermented into alcohol
  - It is typically measured as ADF or RDF
  - **ADF**: **Apparent Degree of Fermentation**
    - The Original gravity (OG) of the wort prior to fermentation
    - The apparent extract (AE) of the beer after fermentation
      - AE is the final specific gravity of beer converted into degree Plato. This measurement does not take into account the lower density of alcohol compared to water
  - **RDF** : **Real degree of Fermentation**
    - The Original gravity (OG) of the wort prior to fermentation
    - The real extract(RE) of the beer after fermentation
      - RE is the final gravity of the beer, converted to degrees plato and corrected with the lower density of alcohol compared to water

# Brewing Process

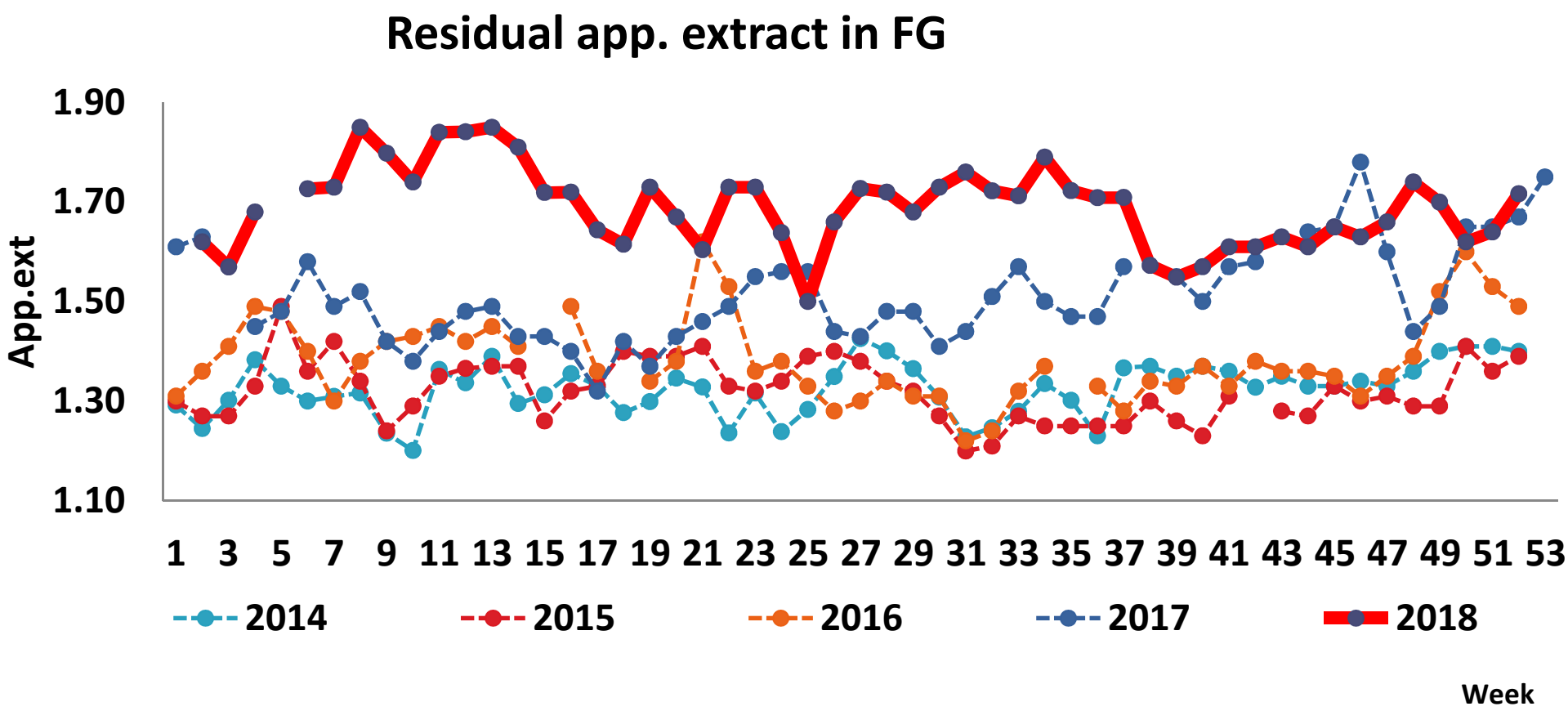
- Why attenuation control is important?
  - Degree of starch conversion has a direct impact on several brewing parameters
    - Beer specification
      - Alcohol content
      - Residual extract
      - Calories
      - Sensory: Mouth feel
    - Brewing Process
      - Extract yield (Cost)

# Brewing Process




*Graph 1. Apparent Degree of Fermentation in finished product*

# Brewing Process




*Graph 2. Residual apparent extract in finished product*

# Brewing Process

*Table 2. Average Malt Qualities 2018*

| Malt Quality | Spc. | avg. 2018 |
|---|---|---|
| Moisture (%) | < 5.0 | 4.3 |
| Extract find grind(%) | > 81.0 | 82.3 |
| Extract coarse grind(%) | | 81.5 |
| Extract(as is)(%) | | 78.8 |
| Extract Different(%) | < 1.2 | 0.8 |
| pH | | 5.9 |
| Colour(EBC) | 4.3-4.7 | 4.3 |
| Total Protein(%) | 10.2-11.2 | 10.3 |
| Soluble Nitrogen(%) | 680-740 | 725.4 |
| Kolbach index(%) | 39-43 | 44.1 |
| FAN(mg/100g) | > 150 | 161.7 |
| 1000 Corn Weight(g) | | 37.1 |
| Hectolitre weight(Kg) | | 58.1 |
| sum of 2.8,2.5(%) | > 90 | 94.9 |
| Tailings (%) | < 1.0 | 1.1 |
| Mealy (%) | > 85 | 90.2 |

# Raw material check sheet

| Raw Material | Controlled spec. | Forward step |
|---|---|---|
| **Malt** | **Yes** | **No** |
| **Adjunct** | - | **Yes** |
| *Rice* | - | *Yes* |
| *Syrup* | *Yes* | *No* |
| **Yeast** | **Yes** | **No** |
| **Brewing Water** | **Yes** | **No** |

# Rice Evaluation

- Study of brewing rice quality related to final beer parameters by TC LAB ( Test Kits ) color , amylose content and RVA with a focus on fermentability

# Rice Evaluation

## General parameters controlled:

- **Physical Evaluation**
  - ✓ *Size, Colour, Odour, Appearance, Foreign matter, Insect and pest.*
- **Chemical Evaluation**
  - ✓ *Moisture, Extract content, Protein Content,*

# Rice Evaluation

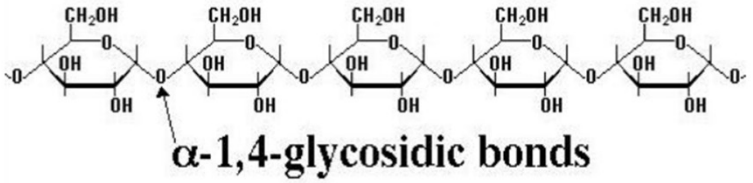
## 1. Amylose Content

### 1. Amylose standard method with Spectrophotometer

### 2. Rapid Test with TC Lab Test

**Principle**

- Amylose with α 1,4 bond (Helix long chain) will react with Iodine solution
- Iodine incorporated into the helix structure resulting in dark color



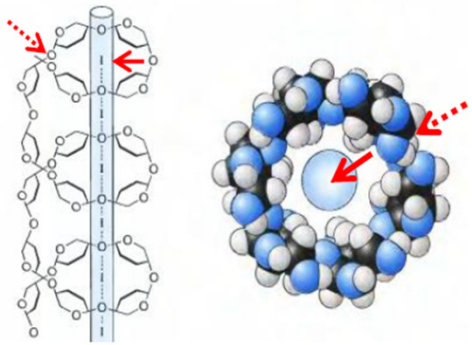
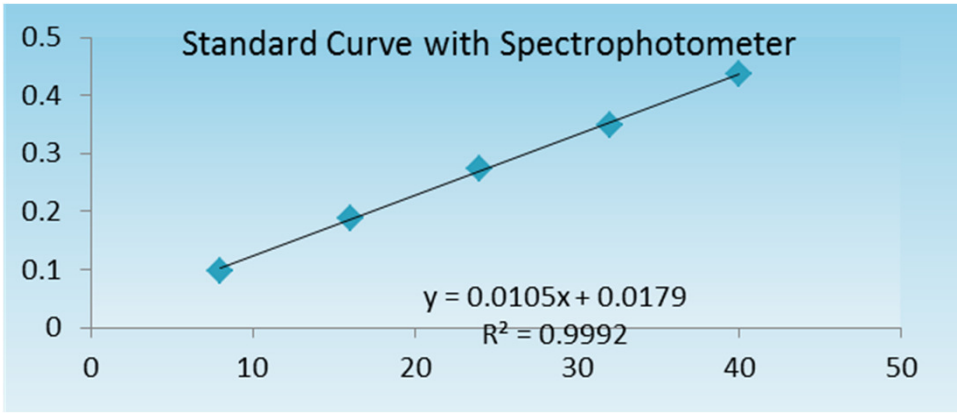



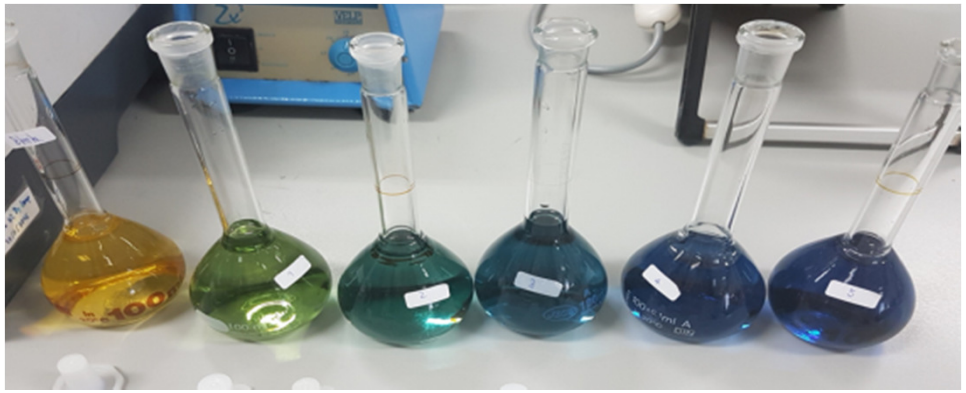
*Figure 9 .Amylose Helix chain*
*.Thanoporn Ratithammatorn, 2016*

# Amylose Test

Absorbance of UV visible light




% amylose



Low ← Amylose → High

## Amylose Standard Test

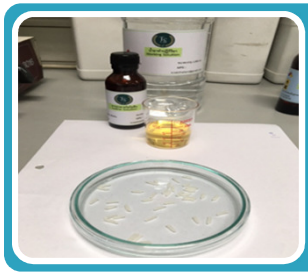
Reference

- **THAI AGRICULTURAL STANDARD**

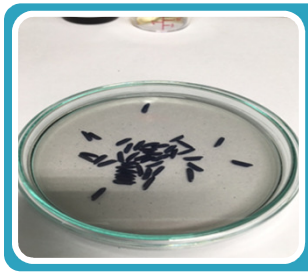
**TAS 404- 2017**

*Figure 7. Standard color for amylose content with standard method*

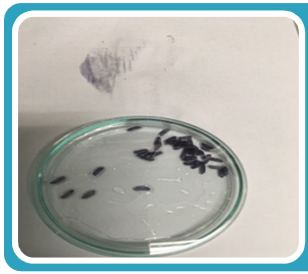
# Amylose Test Kit



*1. Solution Preparation 20 ml + Iodine solution*



*2. Pour Solution 1 to 40 rice corns and observe for 20 seconds*



*3. Rinse solution out and clean with fresh water, Amylose will be coloured dark*

*Figure 8. Amylose test kit procedure*

# Amylose Test Kit

Rapid Test Kit compared with Standard method

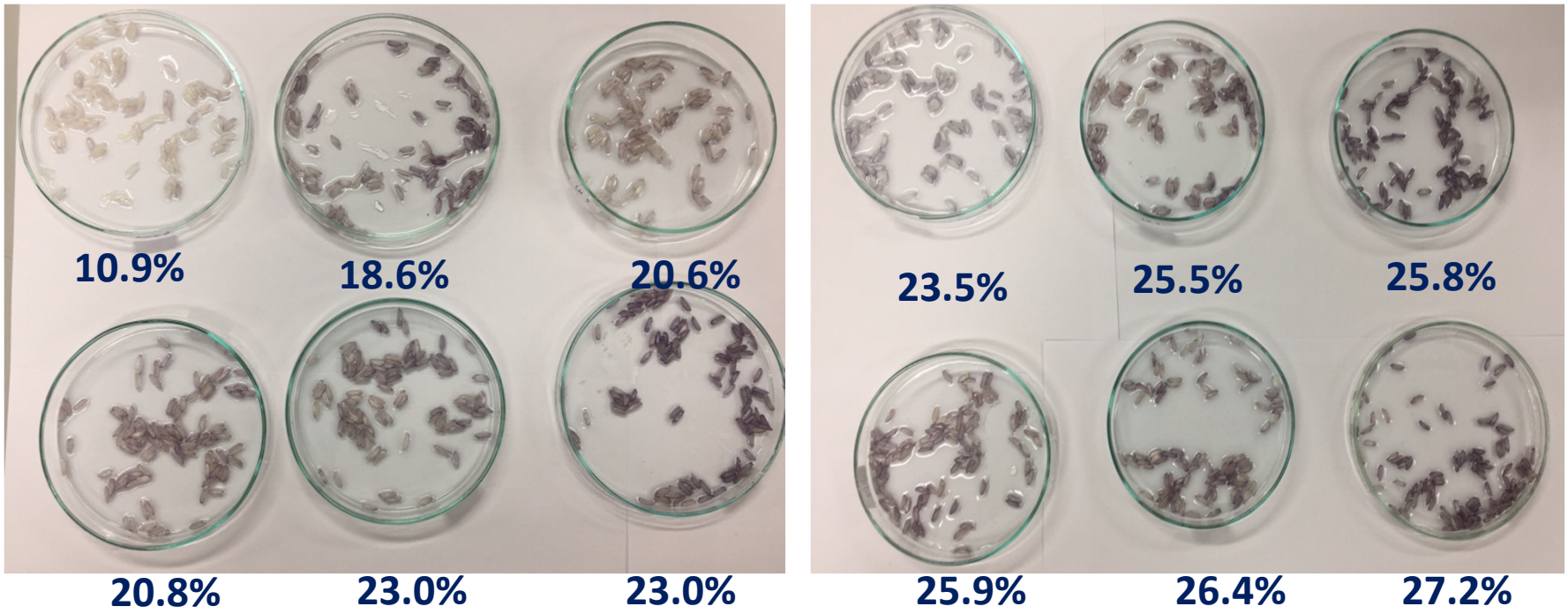
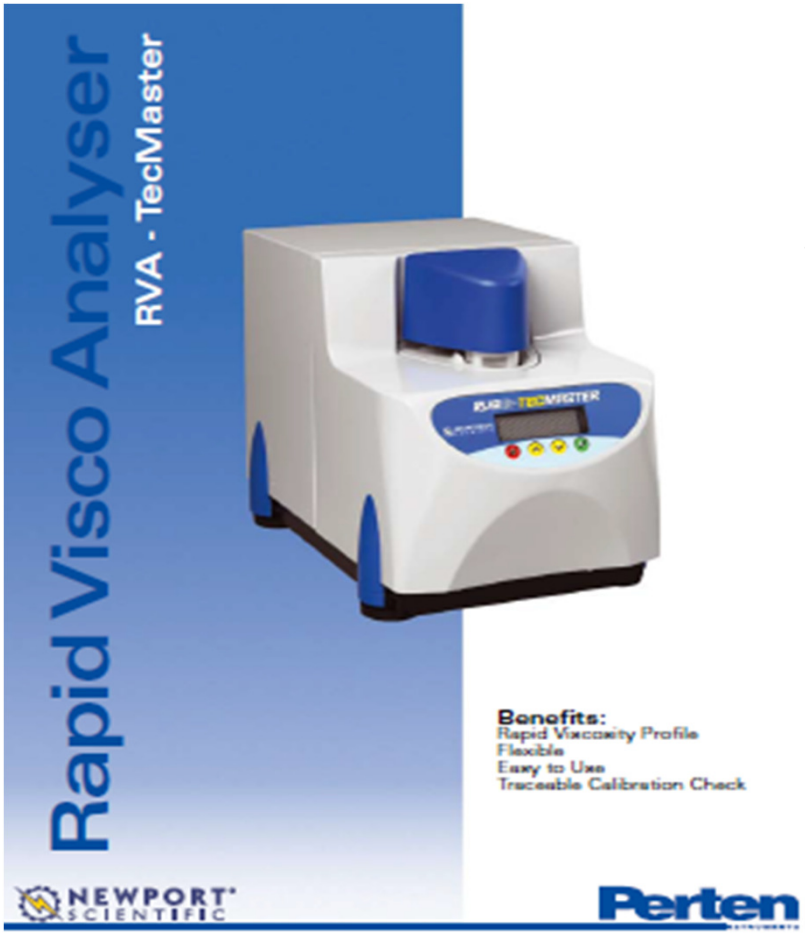



*Figure 9. Darkness of Amylose content*

# RVA (Rapid Viscosity Analyser)




## Rapid Visco Analyser (RVA)

*The Rapid Visco Analyser(RVA) is a heated, stirring viscometer with a ramped temperature control and variable shear capability optimized for testing the viscous properties of starch, grain, flour and foods*.

During a standard starch analysis, the starch is heated in an aqueous environment. The starch granule imbibes water and swell. The internal crystalline structure melts (Gelatinization), the granule itself break down and gels are formed. The viscosity changes produced by heating and cooling starch in water generally provide a characteristic pasting curve.

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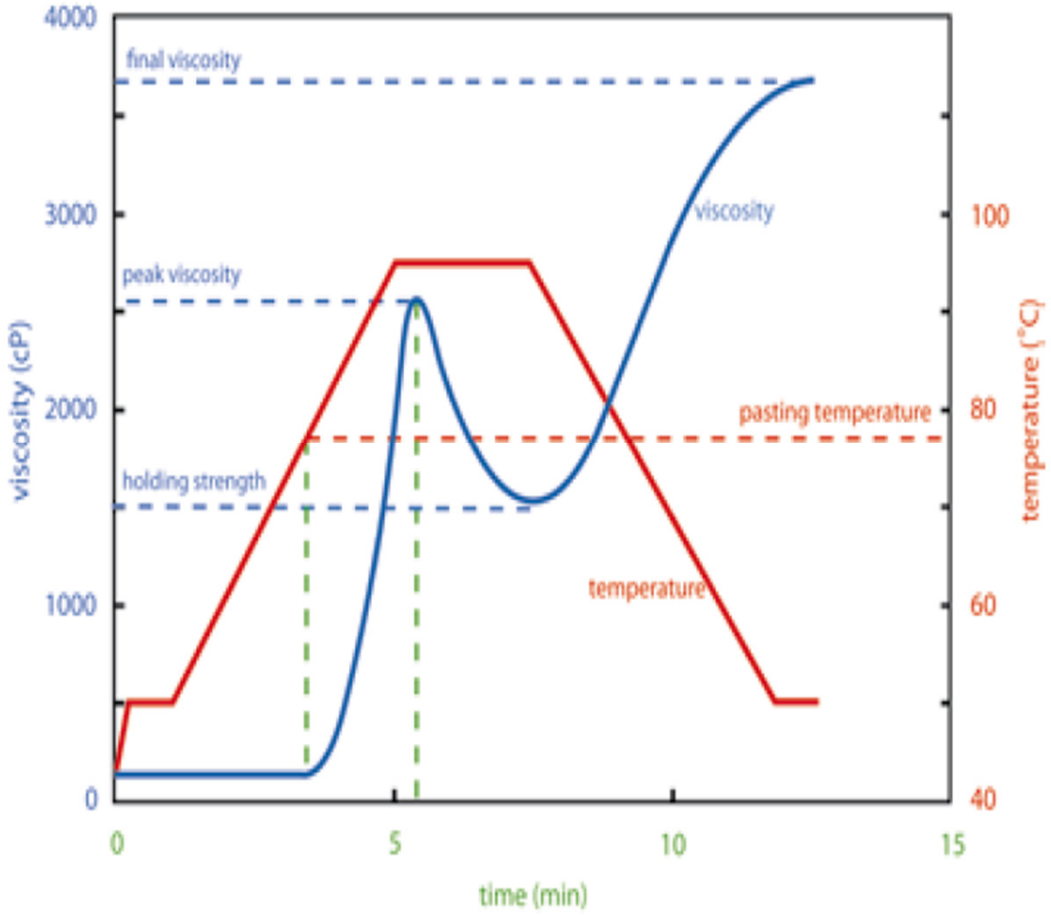
# RVA (Rapid Viscosity Analyser)




- **What RVA tells us ?**
  - Pasting temperature
  - Peak Viscosity
  - Break down
  - Final Viscosity
  - Setback

*Figure 10. RVA parameters Profiles*

# RVA (Rapid Viscosity Analyzer)

*Table 3. Gelatinization temperature of cereal*

| Raw material | Starch content wt% "as is" | Gelatinisation temp., °C |
|---|---|---|
| Barley | 54 - 65 | 53° - 63° |
| Maize (Corn) | 60 - 63 | 68° - 74° |
| Maize (Corn) Grits | 71 - 74 | 62° - 75° |
| Maize (Corn) Starch | 71 - 74 | 62° - 74° |
| Manioc / Cassava | 20 - 30 | 51° - 65° |
| Manioc / Tapioca Meal | 65 - 80 | 51° - 65° |
| Oats | 40 - 63 | 55° - 62° |
| Potato | 15 - 20 | 54° - 69° |
| Potato Starch | 65 - 85 | 56° - 69° |
| Rice | 65 - 70 | 65° - 75° |
| Rice Grits | 57 - 88 | 61° - 78° |
| Rye | 55 - 62 | 55° - 70° |
| Sorghum (Milo) | 55 - 65 | 70° - 78° |
| Sorghum (Milo) Grits | 70 - 74 | 68° - 75° |
| Triticale * | 63 - 69 | 55° - 70° |
| Wheat | 58 - 62 | 58° - 65° |
| Wheat Starch | 67 - 69 | 52° - 75° |
| Barley Malt | 35 - 56 | 61° - 65° |

White rice milled with Rice Hammer mill model 120 (size 0.80 mm)

↓

Moisture content measured with NIR

↓

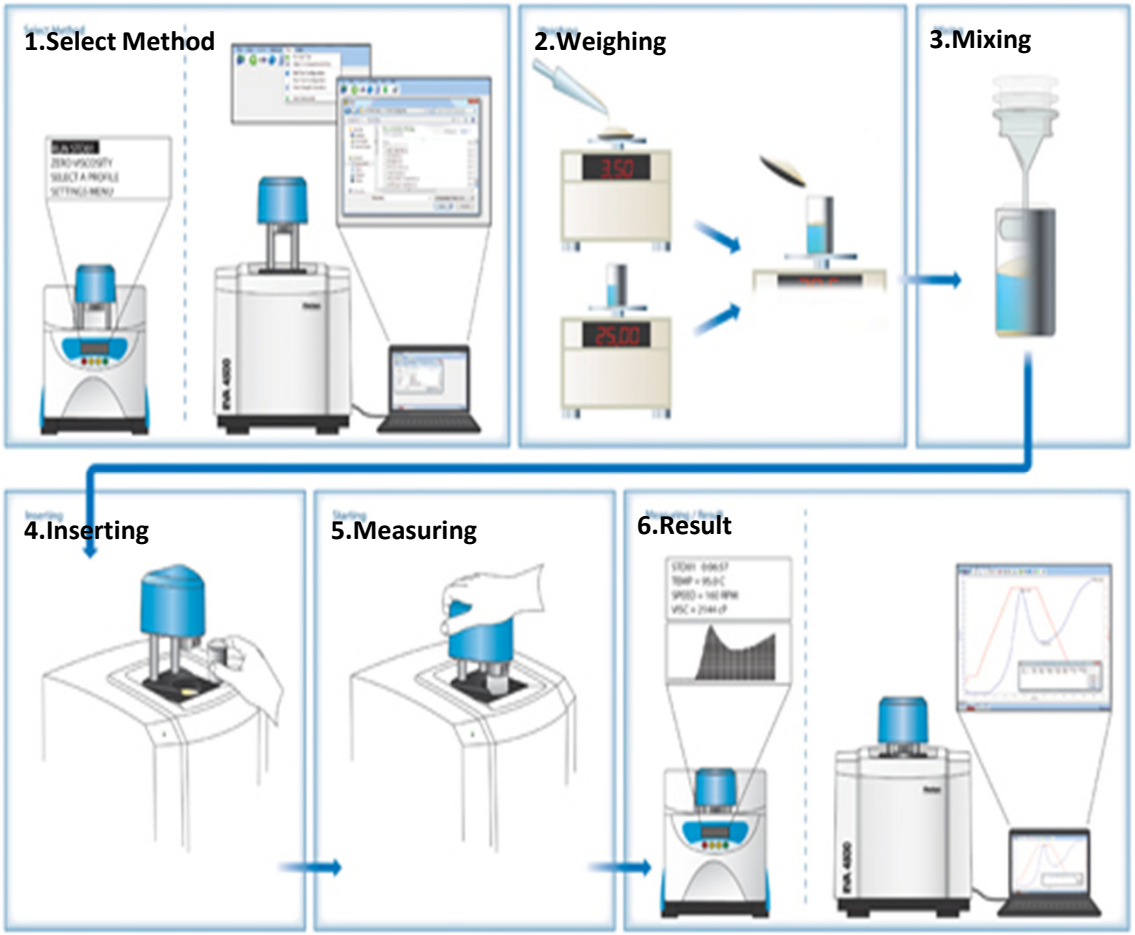
Put moisture in program to calculate rice weight and distilled water

↓

Bring rice sample in RVA Analyser

novozymes
Rethink Tomorrow

# RVA (Rapid Viscosity Analyzer)




- ***1. Select Method***
  Open the appropriate RVA method in TCW software or select the appropriate RVA method using the instrument keypad if using a stand alone RVA.
- ***2. Weighing***
  Accurately weigh your sample and water using an electronic balance. Add first the water and then the sample into the canister.
- ***3. Mixing***
  Place a paddle into the canister, mix and push down any sample lumps.
- ***4. Inserting***
  Slide the paddle into the RVA motor coupling.
- ***5. Starting***
  Depress the tower to lower the canister into the RVA and start the test.
- ***6. Measuring***
  The viscosity of the sample will be graphed on the monitor or on the display if using a stand alone RVA.
- ***7. Result***
  The test will end automatically and analysis results will be reported.

*Figure 11. RVA analytical step. Perten,2017*

# RVA (Rapid Viscosity Analyzer)

## ❑ RVA

- ❖ Comparison Low amylose & High amylose Rice

| Varity | Period | Peak1 | Trougth1 | Breakdown | Final viscosity | Set back | Pasting temp. | Amylose (%) |
|---|---|---|---|---|---|---|---|---|
| Low Amylose Variety | start | 335.00 | 158.54 | 176.46 | 256.21 | -78.79 | 81.4 | 10.90 |
| | 3 m. | 310.88 | 167.50 | 143.38 | 280.00 | -30.88 | 83.8 | 8.20 |
| | 6 m. | 308.96 | 175.83 | 133.13 | 294.67 | -14.29 | 84.6 | 6.89 |
| | 9 m. | 277.75 | 187.04 | 90.71 | 314.29 | 36.54 | 86.2 | 9.20 |
| | 12 m. | 286.04 | 192.79 | 93.25 | 334.54 | 48.50 | 86.3 | 7.60 |
| High Amylose Variety | start | 258.80 | 179.88 | 78.92 | 327.71 | 68.92 | 80.6 | 23.50 |
| | 3 m. | 292.59 | 195.88 | 96.71 | 363.75 | 71.17 | 81.1 | 19.40 |
| | 6 m. | 301.96 | 203.17 | 98.79 | 382.00 | 80.04 | 81.4 | 23.82 |
| | 9 m. | 310.75 | 222.92 | 87.83 | 406.13 | 95.38 | 81.8 | 29.97 |
| | 12 m. | 306.33 | 235.71 | 70.63 | 425.54 | 119.21 | 83.9 | 30.10 |

*Table 4. Comparison RVA result with long shelf life different varieties rice*

# Correlation Coefficient

**Correlation coefficient:**

*statistical index of the degree to which two variables are associated, or related.*

**Direction of the relationship Variables can be positively or negatively correlated.**

- Positive correlation: A value of one variable increase, value of other variable increase.
- Negative correlation: A value of one variable increase, value of other variable decrease

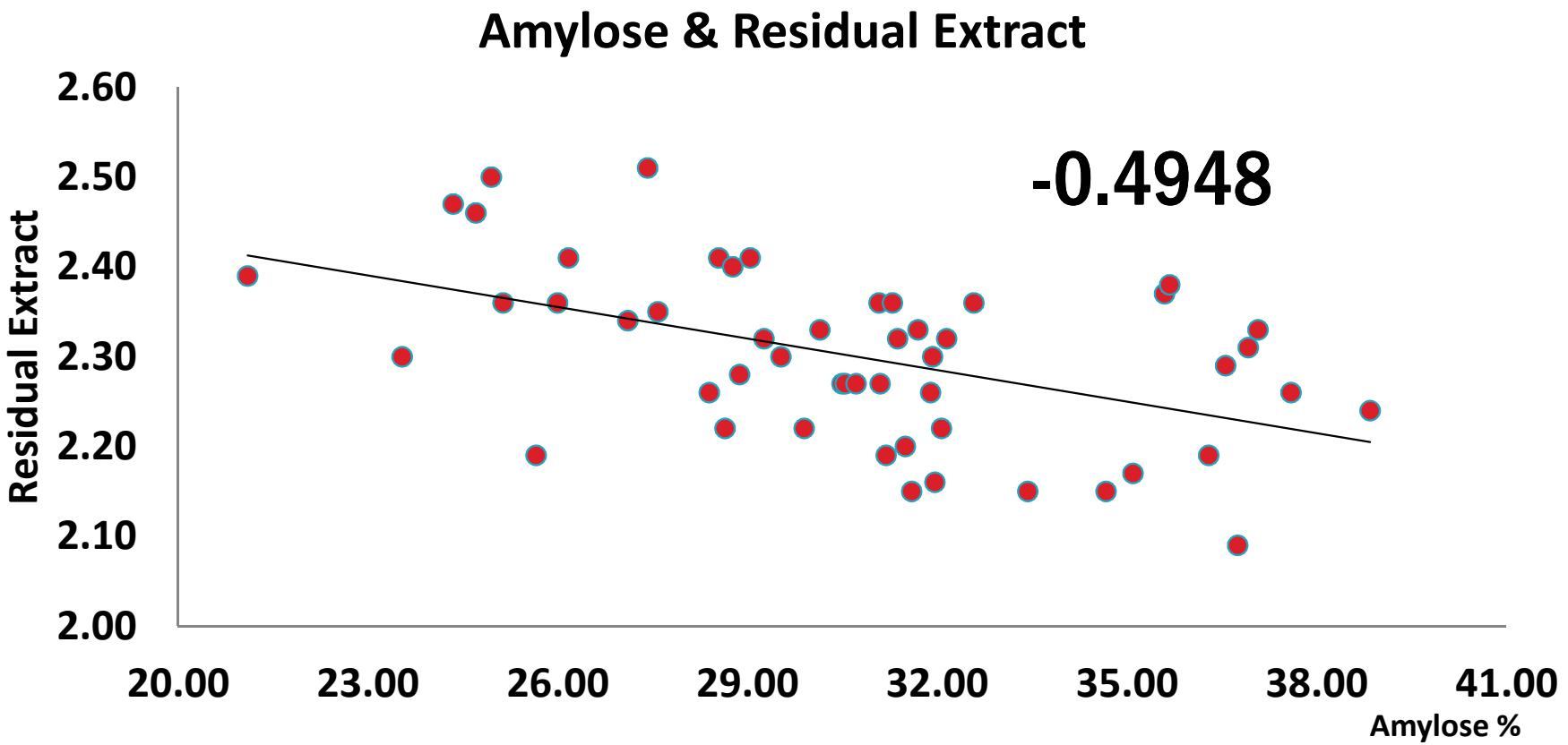
# Correlation Coefficient

## Pearson's correlation coefficient

There are many kinds of correlation coefficients but the most commonly used measure of correlation is the Pearson's correlation coefficient. (r)

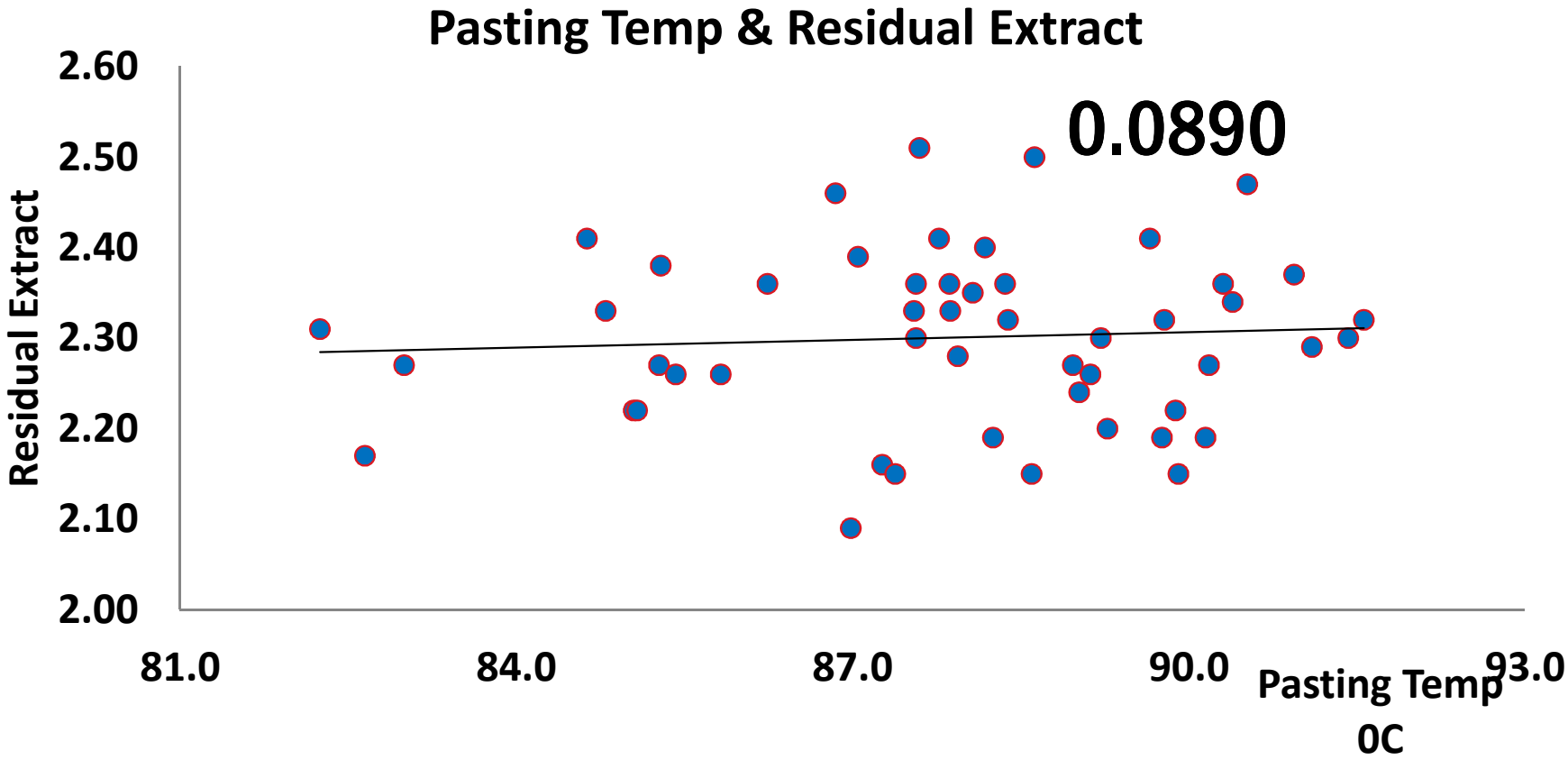
- The Pearson r range between -1 to +1.
- Sign indicate the direction.
- The numerical value indicates the strength.
- Perfect correlation : -1 or 1
- No correlation: 0
- A correlation of zero indicates the value are not linearly related.
- However, it is possible they are related in curvilinear fashion.

# Correlation Analysis



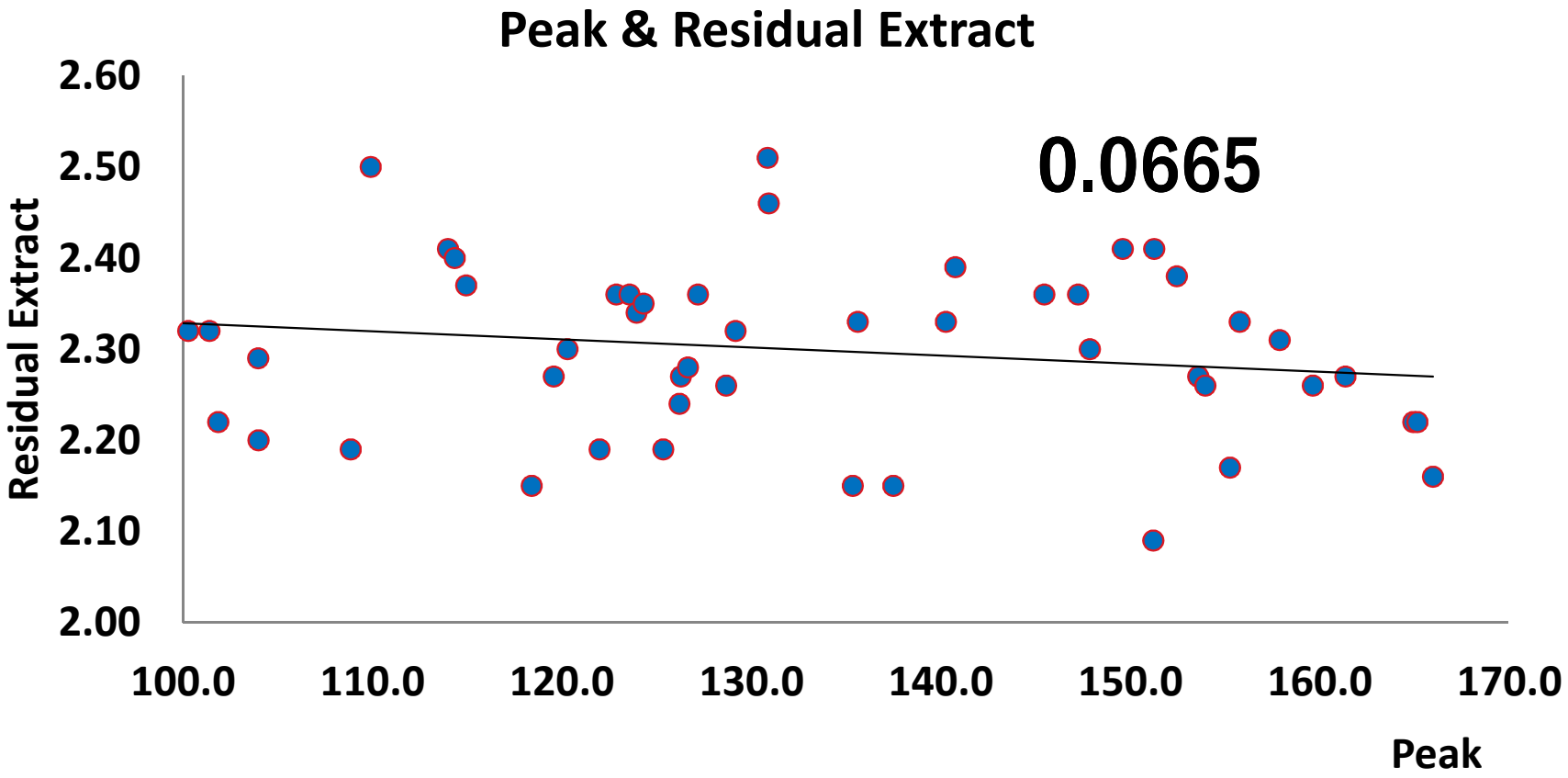

*Graph 3 Correlation between Amylose & Residual extract*

# Correlation Analysis



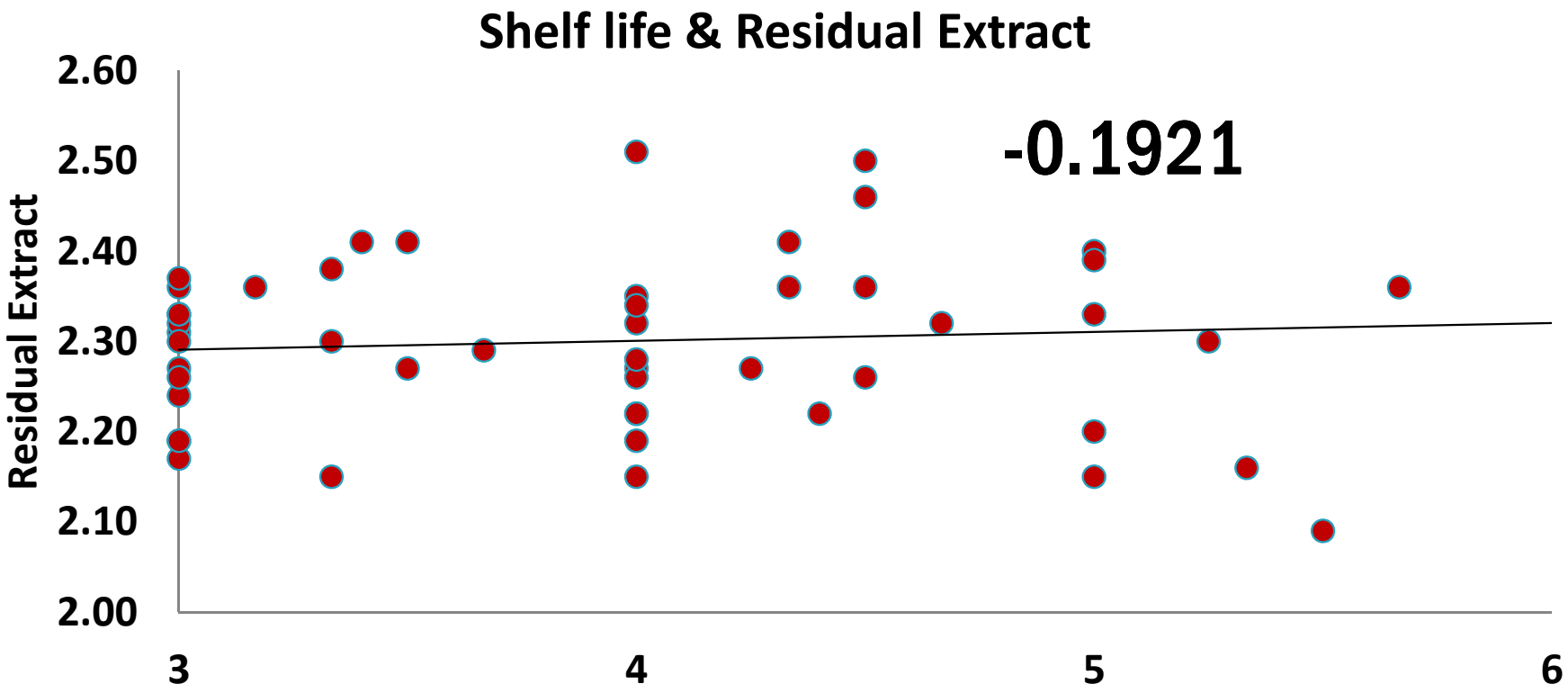

*Graph 4 Correlation between Pasting temp & Residual extract*

# Correlation Analysis




*Graph 3 Correlation between Peak & Residual extract*

# Correlation Analysis



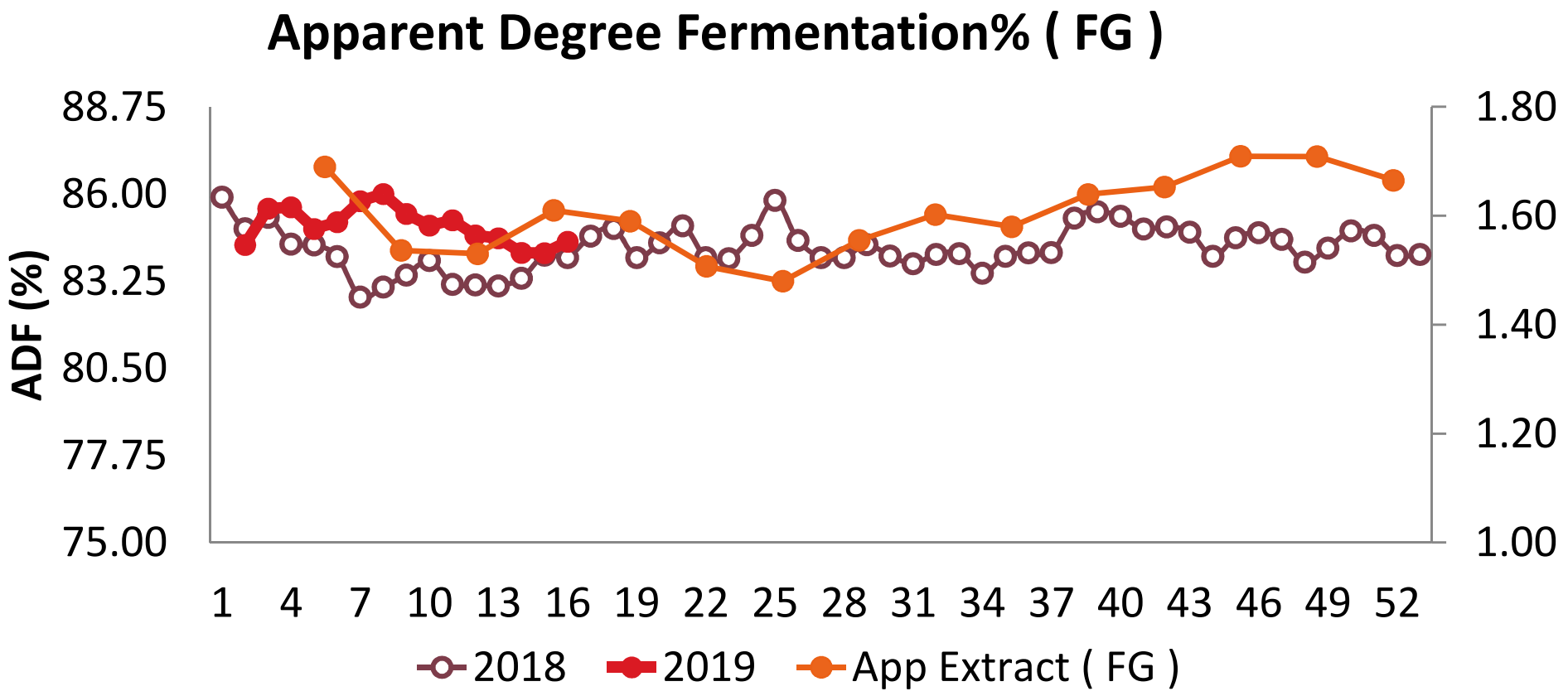

*Graph 3 Correlation between Shelf life & Residual extract*

# Correlation Analysis

| | | % Amylose | Pasting Temp | Peak | Trougth1 | Break down | Past stability ratio | Final viscosity | setback from peak | Shelf Life | Extract ZKG | Org.Ext. | Alc. | Alc. | Real | App.Ext. | pH | ADF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RVA | %Amylose | 1 | | | | | | | | | | | | | | | | |
| | Pasting Temp | -0.2070 | 1 | | | | | | | | | | | | | | | |
| | Peak | 0.3426 | -0.8326 | 1 | | | | | | | | | | | | | | |
| | Trougth1 | 0.2947 | -0.6530 | 0.9415 | 1 | | | | | | | | | | | | | |
| | Break down | 0.3380 | -0.9150 | 0.8655 | 0.6459 | 1 | | | | | | | | | | | | |
| | Past stability ratio | -0.3280 | 0.8607 | -0.7859 | -0.5392 | -0.9783 | 1 | | | | | | | | | | | |
| | Final viscosity | 0.3935 | -0.7954 | 0.9780 | 0.9158 | 0.8538 | -0.7933 | 1 | | | | | | | | | | |
| | setback from peak | 0.4118 | -0.3286 | 0.4893 | 0.4400 | 0.4542 | -0.4881 | 0.6606 | 1 | | | | | | | | | |
| | Shelf life | -0.3821 | 0.1477 | -0.1884 | -0.0848 | -0.3006 | 0.3647 | -0.2091 | -0.1960 | 1 | | | | | | | | |
| | Residual ExtractZKG | -0.4823 | 0.0861 | -0.2155 | -0.1904 | -0.2051 | 0.2026 | -0.2471 | -0.2574 | 0.0218 | 1 | | | | | | | |
| Finished Product | Org.Ext. | -0.5188 | 0.1257 | -0.2391 | -0.1752 | -0.2810 | 0.2934 | -0.2542 | -0.2022 | 0.0995 | 0.7847 | 1 | | | | | | |
| | Alc. | -0.0034 | 0.1170 | -0.1593 | -0.1274 | -0.1713 | 0.1650 | -0.1616 | -0.1024 | 0.0491 | -0.2734 | -0.0189 | 1 | | | | | |
| | Alc. | -0.0816 | 0.1314 | -0.1917 | -0.1502 | -0.2109 | 0.2062 | -0.1966 | -0.1317 | 0.0567 | -0.1312 | 0.1345 | 0.9776 | 1 | | | | |
| | Real | -0.5037 | 0.1013 | -0.2039 | -0.1457 | -0.2451 | 0.2590 | -0.2185 | -0.1795 | 0.0892 | 0.8127 | 0.9866 | -0.1809 | -0.0277 | 1 | | | |
| | App.Ext. | -0.5072 | 0.1005 | -0.2024 | -0.1459 | -0.2414 | 0.2544 | -0.2173 | -0.1802 | 0.0898 | 0.8188 | 0.9810 | -0.2114 | -0.0590 | 0.9994 | 1 | | |
| | pH | 0.0780 | -0.0148 | -0.2149 | -0.3448 | 0.0258 | -0.0759 | -0.2292 | -0.1845 | -0.2744 | 0.0372 | 0.0851 | 0.0878 | 0.1012 | 0.0709 | 0.0666 | 1 | |
| | ADF | 0.4993 | -0.0950 | 0.1944 | 0.1396 | 0.2327 | -0.2462 | 0.2098 | 0.1773 | -0.0850 | -0.8208 | -0.9737 | 0.2446 | 0.0933 | -0.9978 | -0.9993 | -0.0672 | 1 |

*Table 6. Example correlation between rice qualities and expected finished product*

# Conclusion




*Graph 3. Apparent Degree of Fermentation in finished product*

# Conclusion

## Pre delivery Test

- **Physical Evaluation**
  - *Color, Odour, Foreign matter*
- **Chemical Evaluation**
  - *Extract, pH, Amylose %, 100 grain weight*
- **RVA Test**
- **Shelf life Test**

**PREDELIVERY RICE REPORT** — KHON KAEN BREWERY CO., LTD.

Analysed date : *Analysed : Piyachat S.*

Sample : (Pre delivery) : Supplier 1

Physical Evaluation

| Parameter | Colour | Odor | Appearance | Immature , Other Seed and Foreign Matter combined | Live Bugs and insect | Whole kernel |
|---|---|---|---|---|---|---|
| *Specification* | *White* | *Normal* | | *< 1(%w/w)* | *No* | |
| Result | White | Normal | Whole Grain | 0 | No | 93 |

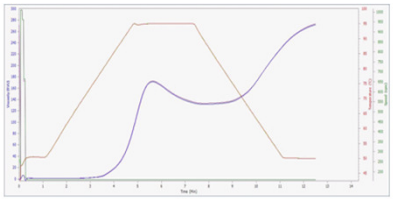
Chemical Evaluation

| Parameter | Extract of cereal, as is (%) | Extract of cereal, dry basis (%) | pH | %amylose | 100grain weight |
|---|---|---|---|---|---|
| *Specification* | *>78* | | | *>20* | *2.6-2.8* |
| Result | 81 | 94 | 5.98 | 33 | 2.1 |

3 RVA

| Parameter | isture (%) | Peak 1 | Trough 1 | Breakdow | Final Visc | Setback | Peak Time | Pasting | Pasting | Peak Temp |
|---|---|---|---|---|---|---|---|---|---|---|
| *Specification* | *<14* | | | | | | | *<90* | | |
| Dup.1 | | 170.92 | 131.42 | 39.50 | 271.58 | 100.67 | 5.60 | 84 | 3.87 | 95.05 |
| Dup.2 | | 172.58 | 133.00 | 39.58 | 273.08 | 100.50 | 5.67 | 84 | 3.87 | 95.05 |
| Average | 13 | 171.75 | 132.21 | 39.54 | 272.33 | 100.59 | 5.64 | 84 | 3.87 | 95 |

| Parameter | timate Postharvested shelf life (mon | Hight amylose test kits (%stain) | Colour (L*) | Colour (a*) | Colour (b*) | Colour (YI) |
|---|---|---|---|---|---|---|
| Specification | | | | | *<21* | *<43* |
| Result | 5 | 100 | 76 | 0 | 16 | 34 |



Physical - Chemical Evaluation Suggestion:.....

☐ Acceptable

☐ Unacceptable .....

Approved By:.....

Production Manager

Date :...../...../.....

*Figure 15. Pre delivery rice quality parameters testing*

# Conclusion

## Rice quality parameters

- **Physical Evaluation**
  - *Color, Odor, Foreign matter*
- **Chemical Evaluation**
  - *Extract, pH, **Amylose %**, 100 grain weight*
- **RVA Test**
- **Shelf life Test**

**KHON KAEN BREWERY CO., LTD.**
**RICE ANALYSIS REPORT**

**Rice Supllier : Supplier 1**

| Parameter | Result | | | | | Average |
|---|---|---|---|---|---|---|
| | **Received Date** | 7/5/2019 | 8/5/2019 | 9/5/2019 | 10/5/2019 | |
| | **Lot No.** | LHW50 | LHW50 | LHW50 | LHW50 | |
| | **Silo** | 2 | 3 | 3 | 3 | |
| | **Specification** | | | | | |
| **Physical Evaluation** | | | | | | |
| Colour | White | White | White | White | White | |
| Odor | Normal | Normal | Normal | Normal | Normal | |
| Appearance | | Whole grain | Whole grain | Whole grain | Whole grain | |
| COA of Immature , Other Seed and | <1 | 0 | 0 | 0 | 0 | 0 |
| Foreign Matter combined. | (%w/w) | | | | | |
| Insect and other pest. | Shall be without | None | None | None | None | |
| **Chemical Evaluation** | | | | | | |
| Moisture (%) | ≤14 | 14 | 14 | 14 | 14 | 14 |
| Extract of cereal, as is (%) | >78 | 82 | 81 | 81 | 83 | 82 |
| Extract of cereal, dry basis (%) | | 95 | 94 | 95 | 97 | 95 |
| pH Wort | | 5.98 | 5.97 | 5.98 | 5.97 | 5.98 |
| **Physical-Chemical Evaluation** | | | | | | |
| Peak1 | | 146.7 | 139.5 | 146.0 | 136.5 | 142.19 |
| Trougth1 | | 118.5 | 115.5 | 118.5 | 114.9 | 116.82 |
| Breakdown | | 28.3 | 24.1 | 27.5 | 21.6 | 25.36 |
| Final viscosity | | 239.2 | 233.1 | 239.0 | 231.4 | 235.68 |
| Set back | | 92.5 | 93.6 | 93.0 | 94.9 | 93.49 |
| Peak time(mins.) | | 5.8 | 5.9 | 5.8 | 5.9 | 5.86 |
| ***Pasting temp.*** | ***<90*** | ***87*** | ***88*** | ***87*** | ***88*** | ***87*** |
| Pasting time(mins.) | | 4.2 | 4.2 | 4.1 | 4.2 | 4.18 |
| Peak temp. | | 95.1 | 95.1 | 95.1 | 95.1 | 95.06 |
| Estimate Postharvested shelf life (month) | | 5 | 5 | 5 | 4 | 5 |
| Hight amylose test kits (%stain) | | 100 | 100 | 100 | 100 | 100 |
| ***Amylose(%)*** | ***>20*** | ***35*** | ***35*** | ***36*** | ***37*** | ***36*** |
| Colour (L*) | | 76 | 76 | 76 | 76.7 | 76.4 |
| Colour (a*) | | 1 | 1 | 1 | 0.6 | 0.7 |
| Colour (b*) | <21 | 17 | 17 | 17 | 17 | 17 |
| ***Colour (YI)*** | ***<43*** | ***36*** | ***36*** | ***36*** | ***36*** | ***36*** |
| 100grain weight | 2.6-2.8 | 2.2 | 2.2 | 2.3 | 2.3 | 2.2 |

**Caution Note :**

**Corrective Action :**
☐ Corrective in Brewhouse.
☐ Others.....

**Physical - Chemical Evaluation**
☐ Acceptable
☐ Unacceptable

Analysed By : Scientist
Date :

Contd By :..... Beer Quality Control Department Manager
Date : ...../...../.....

Approved By :..... Production Manager
Date : ...../...../.....

*Figure 16. Rice receiving rice quality parameters documents*

# Q&A