ProfilePrint

Rice Whitepaper

Fingerprinting Technology for Purity Assessment of Premium Rice

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Rice: a staple amongst staples

Rice accounts for a third of the crops cultivated worldwide and is grown in more than 100 countries[1,2]. In 2017, world paddy rice production amounted to 758.8 million metric tons (MMT), of which about 70% is used to produce milled rice[2].

Rice is morphologically diverse. Beyond classification as long and short-grained varieties, there are also subvarieties under long-grained rice, such as Hom Mali and Basmati, and Bomba and Arborio as short-grained subvarieties. Rice varieties vary extensively in their taste, aroma and form after cooking, and the above varieties are especially prized in the market.

Is my rice, nice?

Rice is often checked for its botanical origin. Hom Mali rice is appreciated for its fragrant aroma, whereas Basmati rice possesses an exceptionally long grain with a light fluffy texture that lends itself well to Indian cuisine. These outstanding organoleptic properties lead to a much higher price than typical varieties.

Great demand for such rice has led to rampant adulteration. Most often an expensive grain is cut using a cheaper grain to maximise profits. In fact, the Food Standards Agency in the UK found almost one third of all commercial sources of Basmati rice adulterated with non-Basmati varieties. To curb adulteration and to ensure quality control throughout the supply chain, there are several methods currently in place to analyse the purity of rice. One of these methods require the grains to be cooked first to observe for inconsistencies in its organoleptic properties. For example, cooked rice grains may be measured for their length; have their colours analysed or eaten to assess the texture, mouthfeel and taste.

Chemical analysis on the amount of starch, type of starch, protein and fat content may give clues to identity[3], and DNA tests have been used as well to ascertain identity and purity for rice[4] and is used by some regulatory authorities around the world. This testing method is regarded as the gold standard for quality control, particularly in the case of Thai Hom Mali rice and Basmati rice varieties. However, it also adds on more processing steps in grinding, extraction, purification and analysis, and requires considerable expense and time.

Imagine a testing modality that could give reliable results on purity and identity without significant expenses and time, and one which could be deployed on-site at strategic points in the rice supply chain – that is the ProfilePrint solution.

Food fingerprinting, confirming identity, quantifying adulterants

Chemical analyses are destructive, slow and expensive, in addition to requiring highly trained personnel. ProfilePrint offers an alternative known as ‘food fingerprinting’. Briefly, this technology uses spectroscopy to generate a unique molecular profile for each food or ingredient sample in minutes. Coupled with proprietary machine learning methodologies, this fingerprinting technology can discriminate between samples that may be visually similar but genetically different. This has been shown extensively in our work on coffee. Beyond discrimination, ProfilePrint’s fingerprinting technology can quantify adulteration levels, which sees diverse use cases in food ingredient trade, especially with the rise of fraud cases in food. All this is possible on a simple to use platform that is non-destructive, rapid, and requires minimal sample preparation.

Ascertaining the purity of Hom Mali rice

We collected the fingerprint data of 14 levels of rice mixtures created from mixing a specific brand of Thai Hom Mali rice with a blend of standard Thai white long grained rice. This set-up approximates an actual use case where a Hom Mali rice trader may receive Hom Mali rice inadvertently contaminated with leftover inferior rice in a mill or cut with blends of inferior rice for different pricing brackets. Levels of mixtures ranged from 0% Hom Mali rice to 100% Hom Mali rice and each level was prepared in triplicates, with the third set used as the blind test samples. Each replicate was in turn sampled thrice for scanning by our analyser. The samples are detailed in **Table 1**.

Table 1. Details of Hom Mali rice mixtures

Sample	Hom Mali	Standard White	Category
HM 100	100%	0%	Pure
HM 96	96%	4%	Pure
HM 95	95%	5%	Pure
HM 94	94%	6%	Pure
HM 92	92%	8%	Pure
HM 90	90%	10%	Mixed
HM 88	88%	12%	Mixed
HM 85	85%	15%	Mixed
HM 80	80%	20%	Mixed
HM 75	75%	25%	Jasmine
HM 60	60%	40%	Jasmine
HM 40	40%	60%	Jasmine
HM 20	20%	80%	Jasmine
HM 0	0%	100%	Jasmine

Following data collection, we attempted to resolve two different use cases. The first use case calls for discrimination of Hom Mali rice mixtures into three different purity classes. These are "Pure" (≥92%); "Mixed" (≥80%); "Jasmine" (<80%). We put the training data through a classification model with 4-fold cross validation and the results are shown in **Table 2.**

Table 2. Model metrics from trained classification model for Hom Mali rice mixtures

Classification

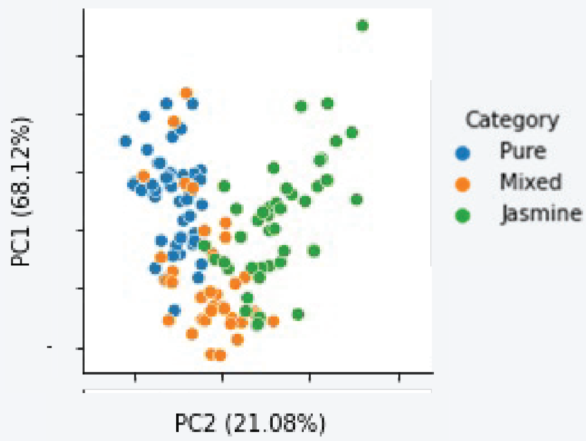
	Recall	Precision
Pure	1.000	1.000
Mixed	0.923	1.000
Jasmine	1.000	0.933
CV R2		0.869
Train Accuracy		0.905
Test Accuracy		0.976

We were able to achieve high levels of recall and precision with an overall accuracy of 97.6%. This is clearly reflected in **Table 3**, with exception of the single erroneous prediction of a "Jasmine" grade as "Mixed" grade. This discriminatory ability of the model was supported by the principal components plot in **Figure 1**, which highlighted the ability of our analyser in separating the different mixtures using their fingerprints.

Table 3. Model classification predictions

	Predicted		
Actual	Pure	Mixed	Jasmine
Pure	15	-	-
Mixed	-	12	-
Jasmine	-	1	14

Figure 1. Principal components plot showing separation of different grades of Hom Mali rice mixtures



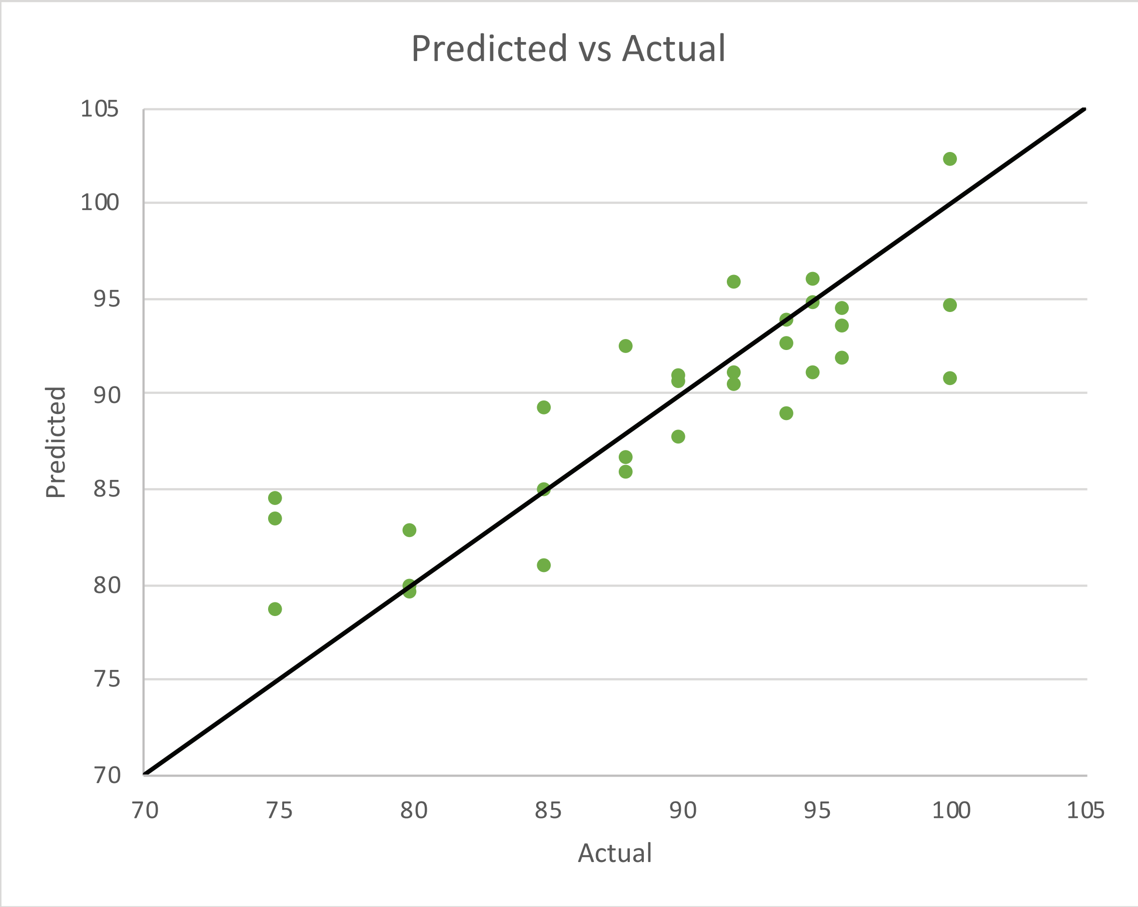
Encouraged by the promising results of this classification, we attempted a regression model to predict the degree of Hom Mali rice purity. Similarly, the model was put through a 4-fold cross validation after training and evaluated on the test set. The results are shown in **Table 4**. The regression model had a root-mean-squared-error (RMSE) of 2.956 and a mean absolute error of 3.908, alongside a reasonable R2 value of 0.722 (n=30) when testing our model on test samples. Notwithstanding, the results were encouraging as a proof of concept of the ability of our technology in predicting the purity of Hom Mali rice to a good level of accuracy.

Table 4. Model metrics from trained regression model for Hom Mali rice mixtures RMSE (root mean squared error) and MAE (mean absolute error) are measures of deviations of predicted values vs actual values.

Regression

CV RMSE	3.033
CV MAE	3.707
Train RMSE	1.955
Train MAE	2.407
Test RMSE	2.956
Test MAE	3.908
Test R2	0.722

Figure 2. Plot of predicted against actual Hom Mali rice mixture proportions



Increasing confidence in the rice supply chain

In the present white paper, the Hom Mali rice classification model described herein demonstrated a reliable overall accuracy of 97.6%, and the regression model was able to substantially predict rice purity with an RMSE of 2.956 and test R2 value of 0.722. These results show promise in ProfilePrint's solution when applied as a quick screening tool at strategic locations along the supply chain. This would enable quality control processes to be faster, more streamlined, and able to provide timely information to inform traders on the fairness of their transactions.

Get in touch with ProfilePrint, and let us discuss how your business can harvest the benefits of our technology.

References

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