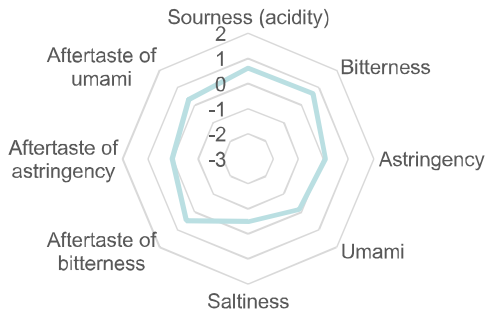
Blending Coffee with Optimization Software

Targeting Blue Mountain coffee

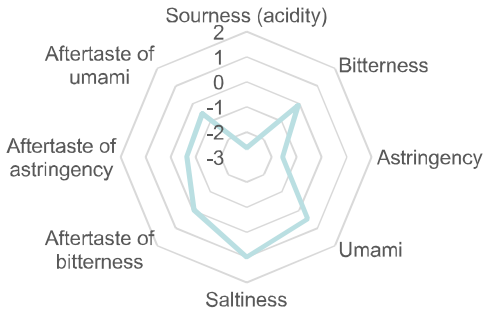
	Acidity	Bitterness	Astringency	Umami	Saltiness	Aftertaste of bitterness	Aftertaste of astringency	Aftertaste of umami
Blue Mountain No.1 (L:20)	0	0	0	0	0	0	0	0
Colombia (EXC) (L:18.5)	0.61	0.68	0.08	-0.11	-0.49	0.49	0.02	0.35
Brazil No.2 (L:18.5)	-2.65	-0.07	-1.57	0.47	0.99	-0.04	-0.63	-0.55
Brazil No.2 (L:20)	-0.61	-0.7	-0.63	0.1	-0.14	-0.53	-0.29	0.11
Brazil No.2 (L:21)	1.3	-1.19	0.16	-0.19	-0.92	-0.48	0.17	0.62
Blended	0.18	0.13	-0.09	-0.06	-0.74	-0.11	-0.14	0.12

	L value	Bleded ratio (%)
Colombia	18.5	49.9
Brazil	18.5	20.3
Brazil	20	7.4
Brazil	21	22.5

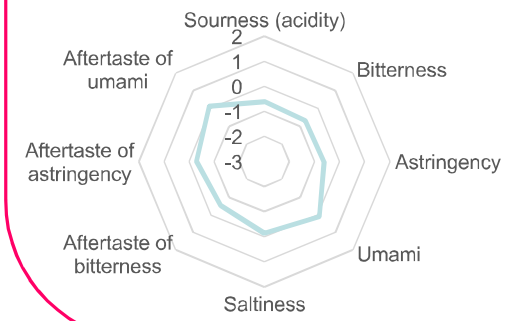
Colombia (EXC) (L:18.5)



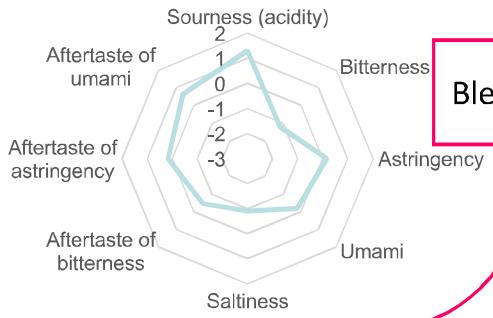
Brazil No.2 (L:18.5)



Brazil No.2 (L:20)

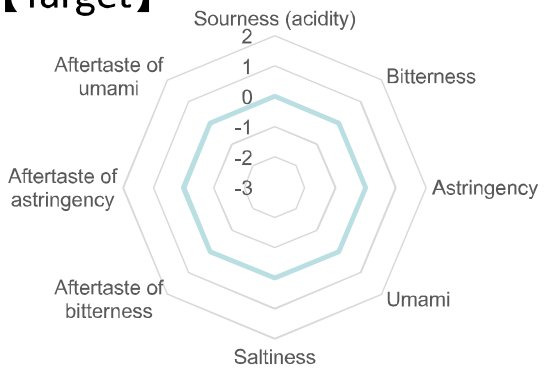


Brazil No.2 (L:21)

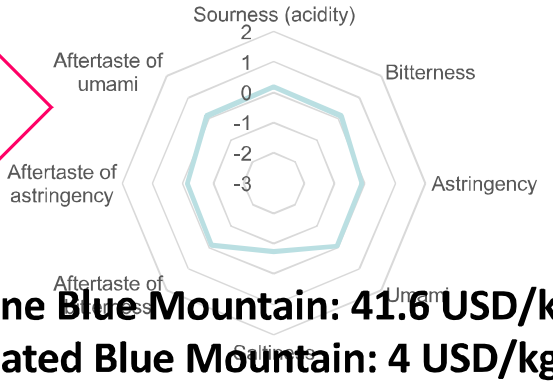


Blended

【Target】



【Final result】



Genuine Blue Mountain: 41.6 USD/kg
Calculated Blue Mountain: 4 USD/kg

Coffee Application

Intelligent Sensor Technology, Inc.

Coffee Laboratory White Stone Va 22578 TEL (866) 244-1578
www.coffeelabequipment.com

Taste qualities available from the Taste sensor

Taste information		Taste substances	Sample
Initial taste (relative value)	Sourness	Tastes derived from organic acids such as citric, tartaric and acetic acids.	Beer, coffee
	Saltiness	Tastes derived from mineral salts such as NaCl and KCl	Soy source, soup, noodle soup
	Bitterness	Bitterness can be hidden flavors or richness at lower concentration	Soup, bean curd, sake
	Astringency	Astringent substances provide richness or secret ingredient at lower concentration	Fruit
	Umami	Taste of soup stock derived from amino acids and nucleic acids	Soup, noodle soup, meat
	Sweetness	Taste derived from sugars and sugar alcohols	
Aftertaste (CPA value)	Bitterness aftertaste	Lasting bitter taste contained in foods and beverages	Beer, coffee
	Astringency aftertaste	Lasting astringent taste produced by catechins and tannins	Wine, tea
	Richness (umami aftertaste)	Lasting umami taste	Soup, noodle soup, meat

Customers

More than 350 systems in the world.

Insent
Intelligent Sensor Technology, Inc.

Sensory test is difficult

Market Research:

"We tried sensory evaluations, comparing to a competitor's products, but it was impossible to grasp market trends because there were too many samples."

"Sensory evaluation puts a burden on panelists."

"Results sometimes differ among panelists."

New Product Development:

"It is difficult to communicate the actual taste of products, because there is no objective measurement of taste."

Product Marketing:

"We have no confidence in whether the final prototype corresponds with development concept."

"It takes a lot of time and expense to provide market research for a new product."

Quality Control:

"it is difficult to check the quality of many samples quickly and easily."

An objective taste measurement is strongly required.

Insent
Intelligent Sensor Technology, Inc.

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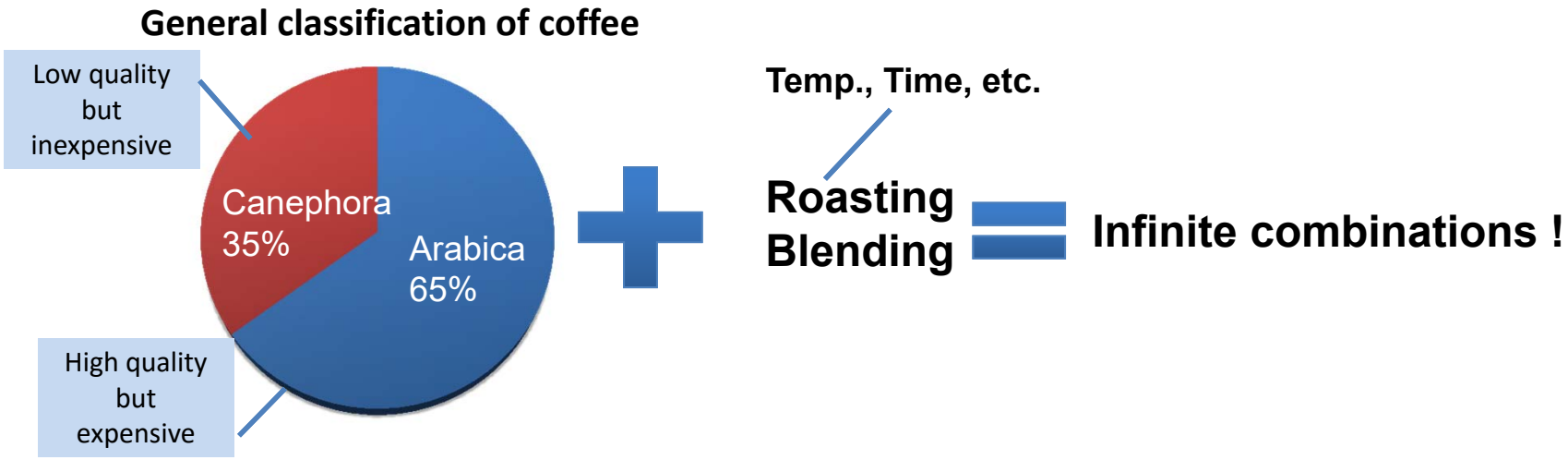


"It takes long time to become a coffee blender, because learning is accomplished through hands on training, and experience."

<u>By using the Taste Sensing System,</u>

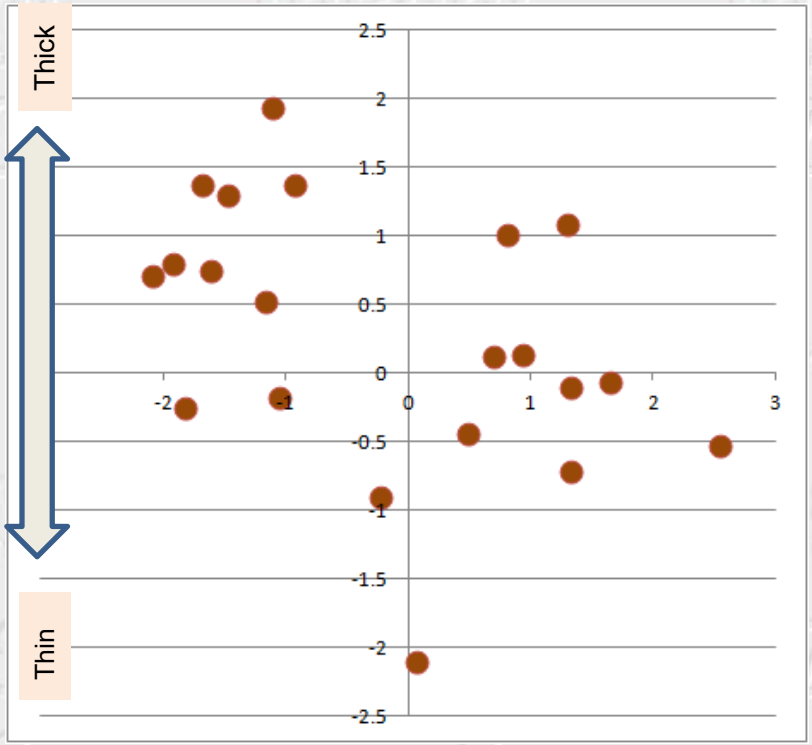
- Accumulated sensor outputs can provide *objective* information on their customers and consumers.

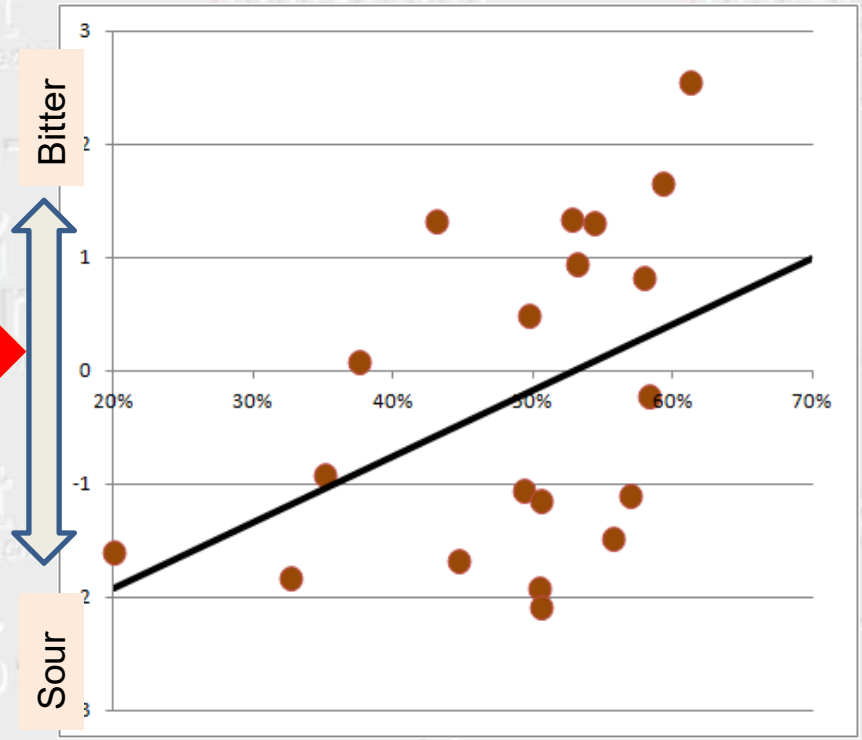
- Product design development time is greatly shortened, because the optimization of taste and the associated costs, cannot be achieved by a trained blender alone.

K. Toko ed., *Science and Technology to Produce Deliciousness of Foods/Medicines and Ensure The Safety*, CMC Publishing (2012) (in Japanese).

POS(point of sales system) data with Taste data

Regular coffee POS data
20, 30, 40 yrs buyer taste preference





Sour ⟷ Bitter

Over 40 ⟷ Less than 40

Data provided by Taste Aroma laboratory inc.

Optimization calculation of coffee beans based on taste with market price

Coffee bean importer, Ishimitsu co, Ltd

- Cost down more than 10%
- Reduction of stock more than 50%

Data base of taste data of beans by TSS

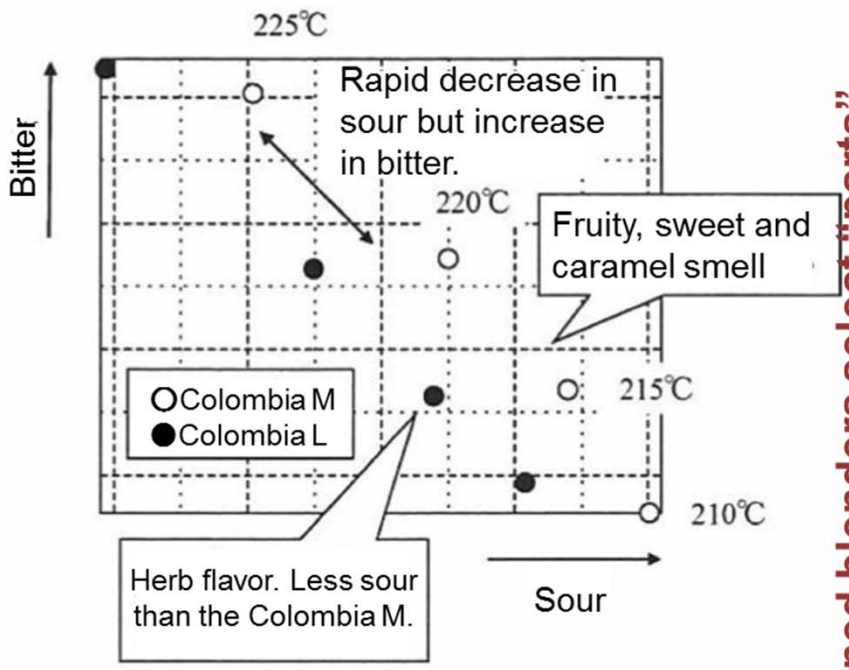
（1）Price ＋ Taste data

（2）Copy taste of target product

（3）Calculate blend ratio for target product at minimum cost

『Food ・Drug Technology to secure Taste and Safety』
Chapter 26 「Development of Coffee product
By use of Taste sensing system」
Author Ishimitcu Co., Ltd Mr. Ishiwaki

Example: visualize of product's qualities



Accumulate tastes and smells data for roasting processes.

K. Toko ed., *Science and Technology to Produce Deliciousness of Foods/Medicines and Ensure The Safety*, CMC Publishing (2012) (in Japanese).

Current procedure
Case: Regular coffee

Measure target products

Select "parts" by trained blenders
Beans, roasting,…..

Select mainly based on **smell** of materials

Mathematical optimization

Analytical determination of optimal combination

Compare with target products

Fine tuning

New products

Trained blenders select "parts"

Example of Coffee product design

Target product

Compare by Taste sensor & Sensory test

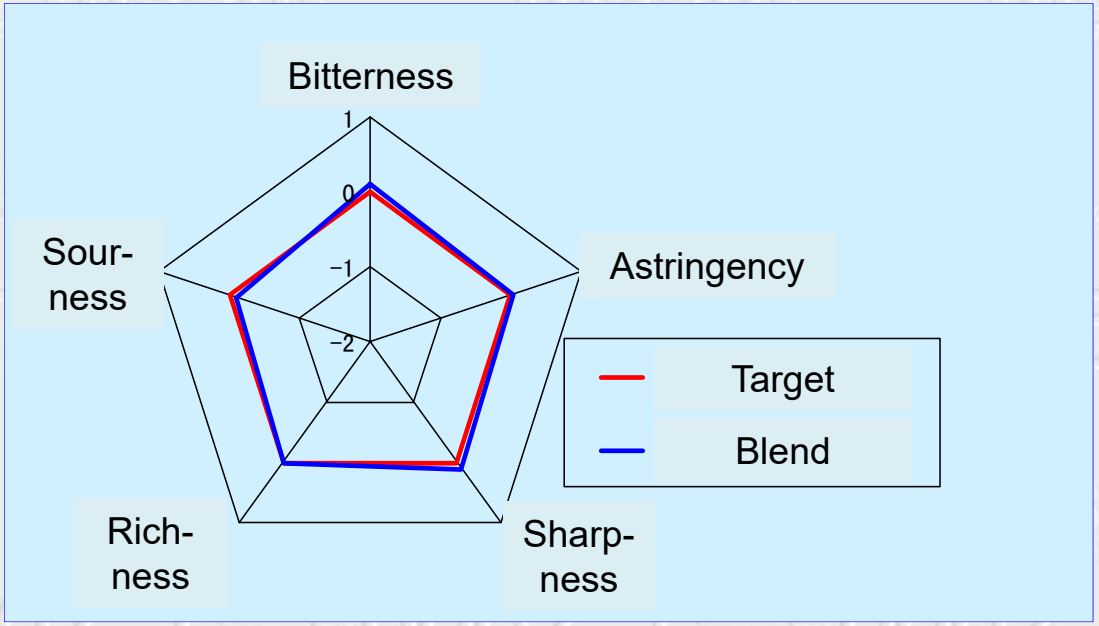
Result

Food design simulator

◆Calculate the condition to find an optimum blend

- Cost
- Number of blendiing
- Quantity of coffee powder
- Taste importance

◆Fine tuning by Taste panelist



10%

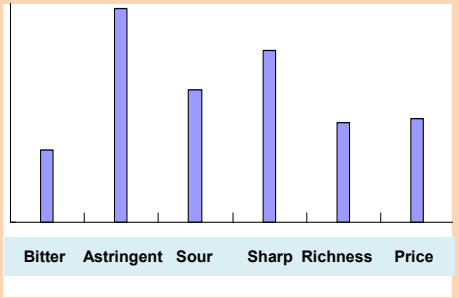
30%

50%

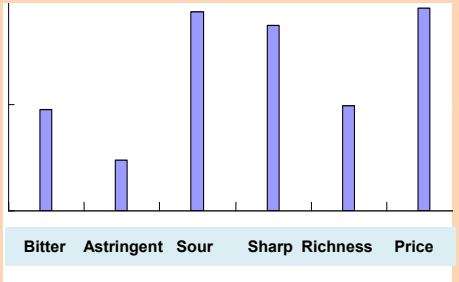
10%

Database

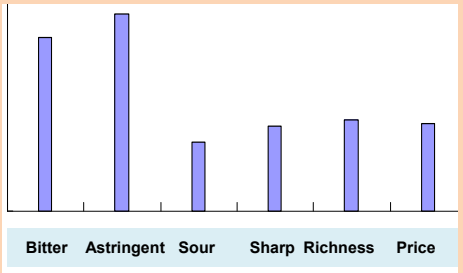
Coffee Bean 1



Coffee bean 2

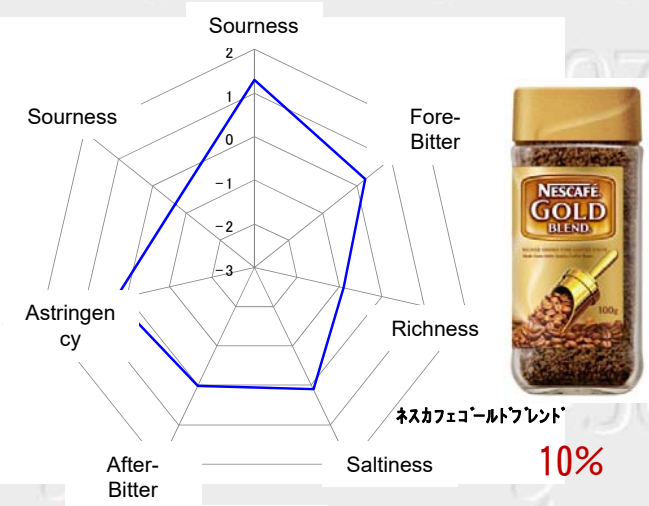


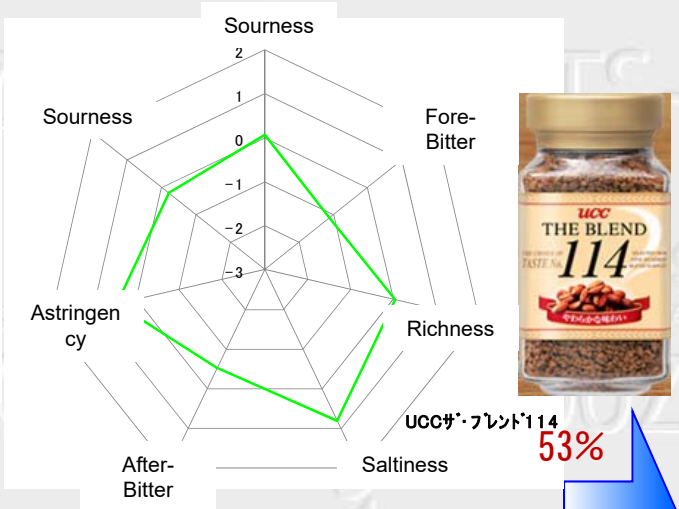
Coffee bean 3

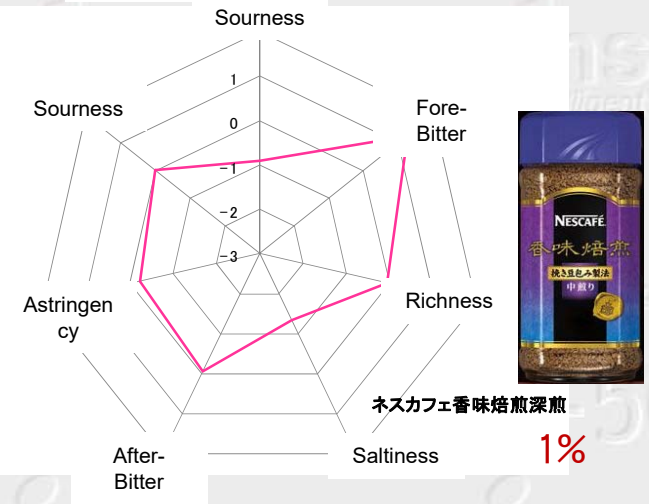


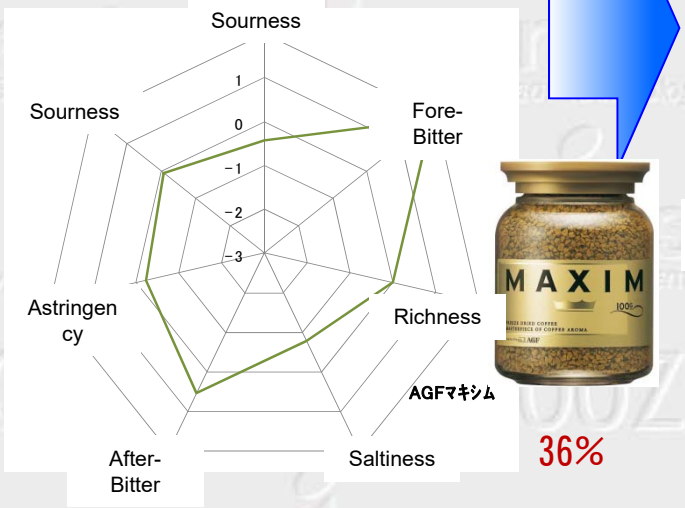
Example

Evaluate Target product first and calculate the blending ratio

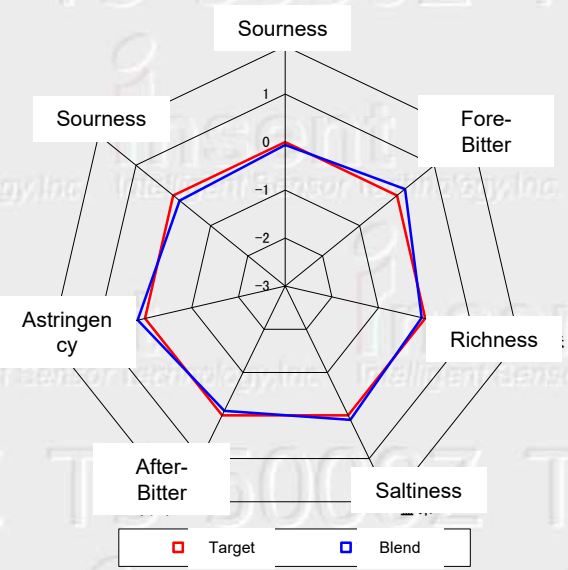








TARGET



◆ How to make coffee sample

Weight 7 gram

Pour 130g hot water

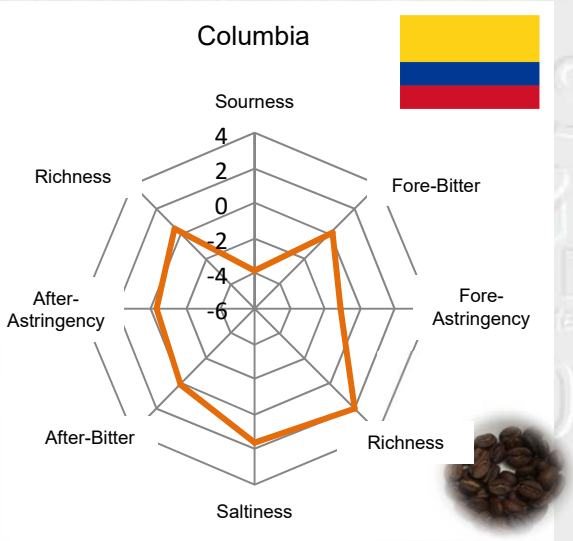
Stir gently

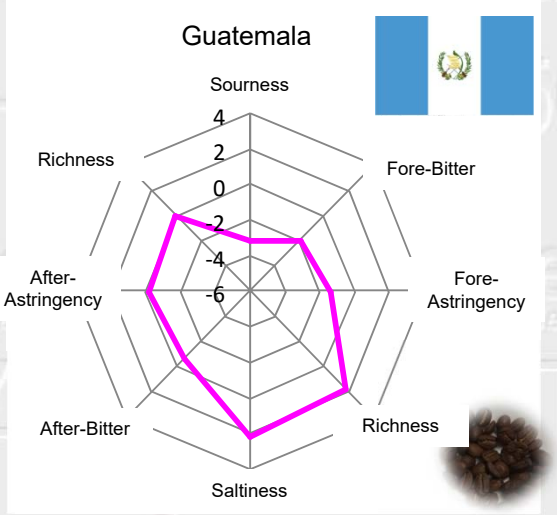
Filter

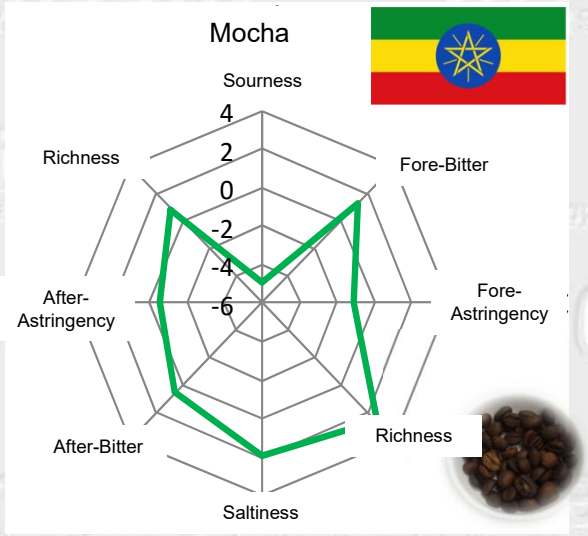
1. Milling coffee bean
2. Take 7g sample
3. Put 130g hot water, keep 10sec
4. Stir slowly 5 times
5. Keep 4 min
6. Filtering
7. Cool sample to ambient temp

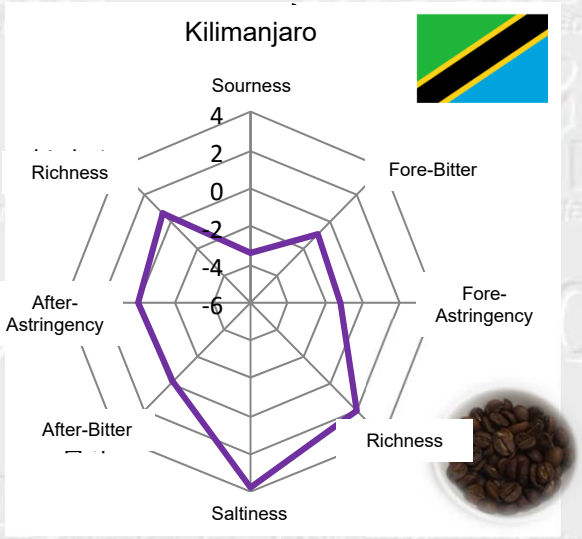
Cooling

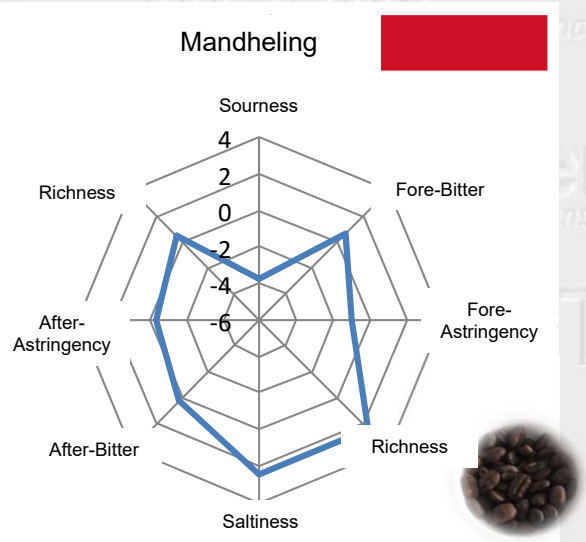
Taste feature from countries



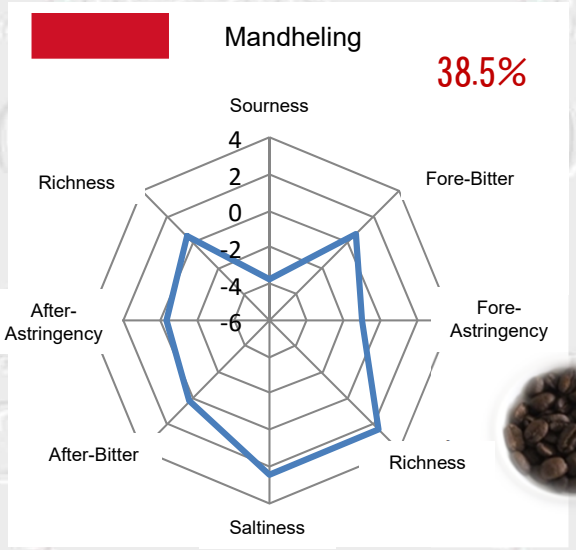


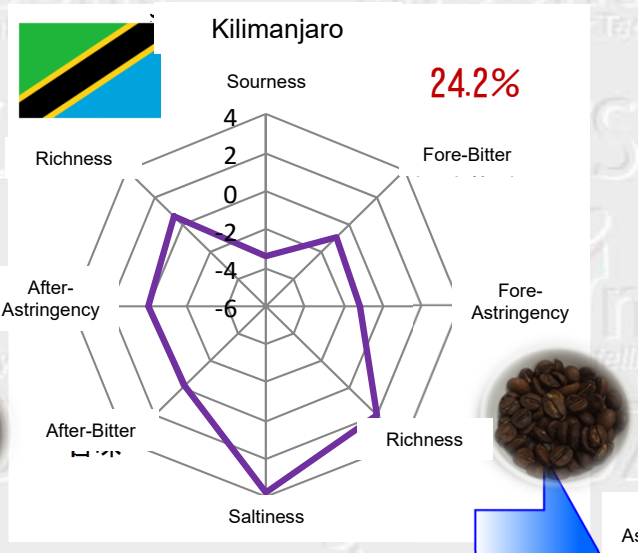


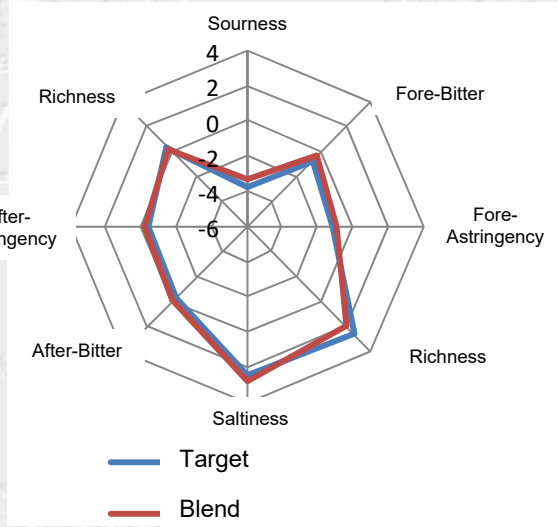




Example: Optimum calculation for Target taste

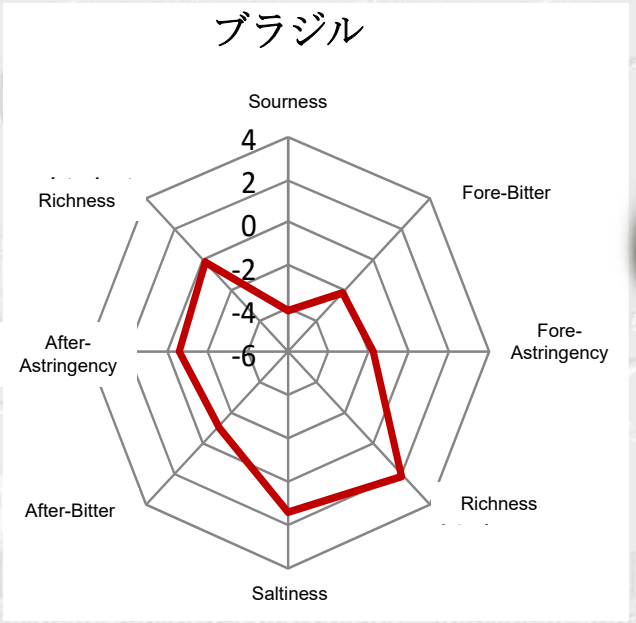






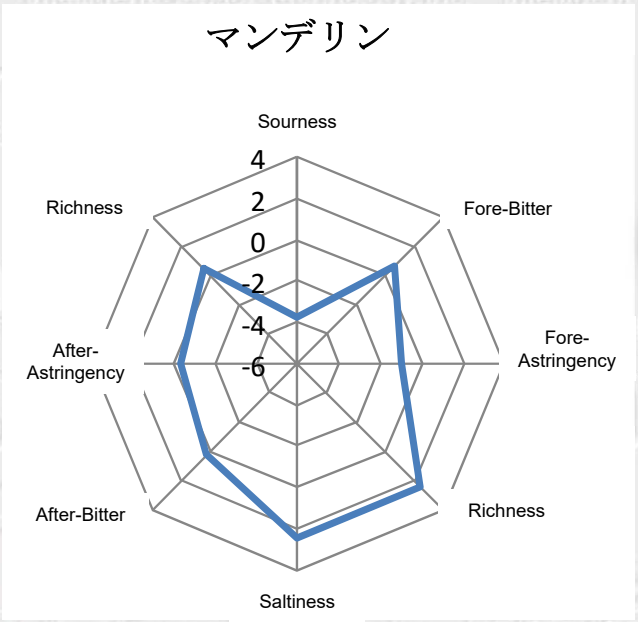
Confirm the taste of blended and target sample are same by taste panelist

Comparison between evaluated data and calculation data

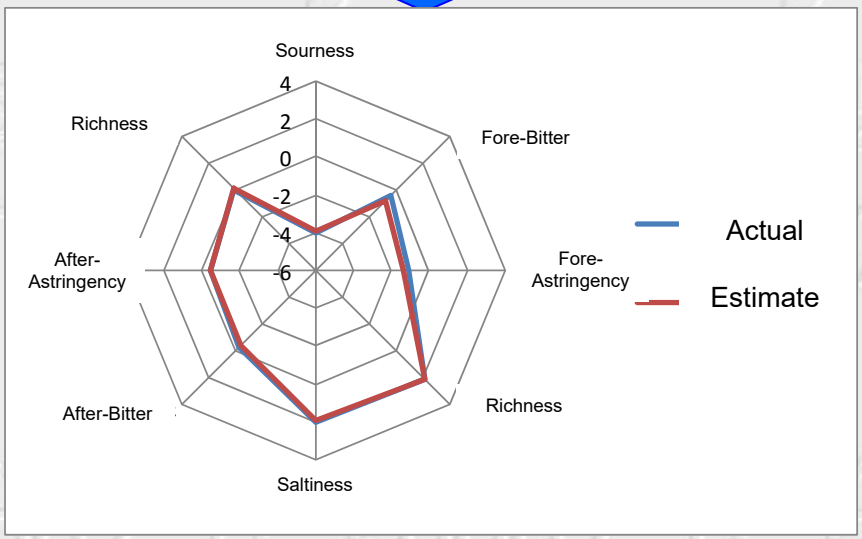


50%

Calculate



50%



Calculated value and actual measurement data are overlapped.

Comparison between TSS and sensory data(Left is TSS、Right is Nikkei MJ(2013/3/4)

TSS

Sensory data by Nikkei

TSS

Sensory data by Nikkei

各メーカー平均値
日本マクドナルド

100円

各メーカー平均値
セブンイレブン

100円

ローソン

180円

プロントコーポレーション

200円

ドトールコーヒー

200円

ファミリーマート

150円

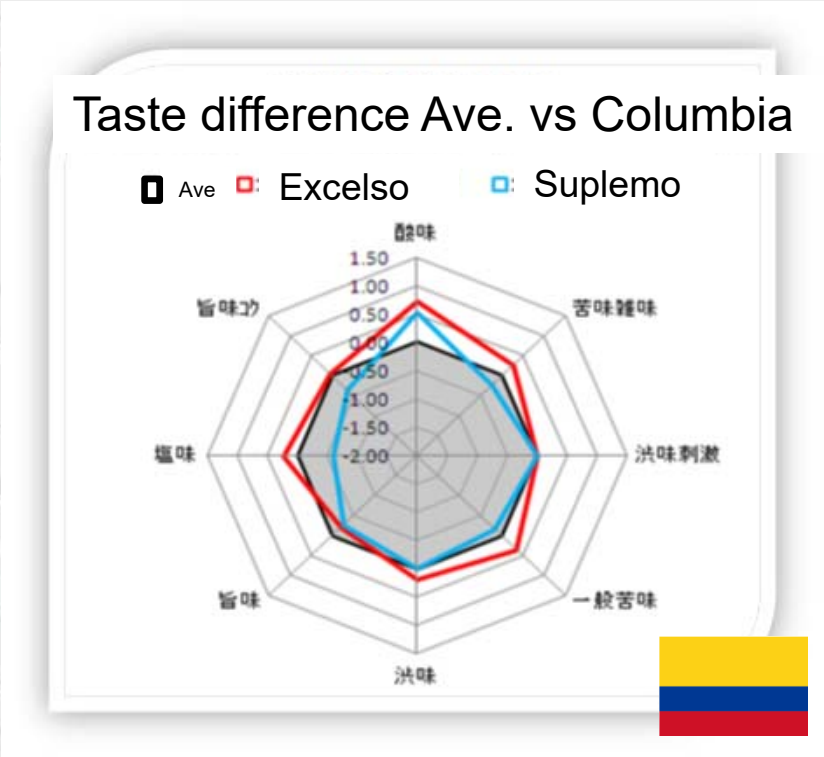
ミニストップ

150円

サークルKサンクス

130円

Taste difference of Bean grade (Columbia and Brazil bean)



KEYCOFFEE

出典：http://www.keycoffee.co.jp/news/2011/pdf/110128-1.pdf

— 人気のモカブレンドがグランドローストでも復活しました！ —

『香りふくらむモカブレンド』発売

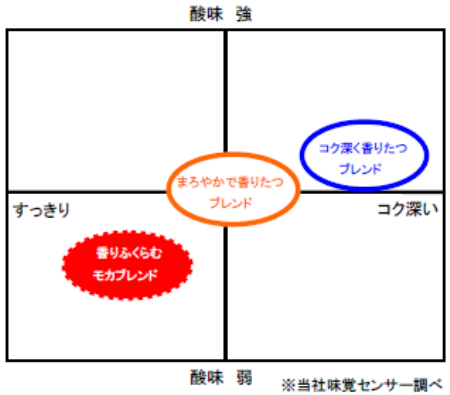
良質なコーヒー豆をじっくりとロースト。酸味を抑えた味わいに仕上げた「グランドロースト」シリーズに、待望のモカブレンドが復活！モカの甘い香りを存分に引き出したやわらかな味わいが特徴です。

【商品概要】

商品名	グランドロースト 香りふくらむモカブレンド
商品の特徴	モカの甘い香りを存分に引き出し、やわらかな味わいに仕上げました。
規格	450g（粉）
賞味期間	12ヵ月
発売日	2011年3月1日
希望小売価格	オープン（参考店頭価格 698円税込）

※商品画像はこちらからご覧いただけます。

http://www.keycoffee.co.jp/photo/2011_ss/mocha.jpg



※当社味覚センサー調べ

好評発売中

グランドロースト シリーズ

良質なコーヒー豆をじっくりとロースト。酸味を抑えた味わいに仕上げ、日々の生活にほっとするひとときを提供するシリーズです。


コク深く香りたつブレンド 450g(粉)


まろやかで香りたつブレンド 450g(粉)


アイスコーヒー 360g(粉)

Summary

①Copy target taste

Blending ratio by Optimum calculation

②Blending study

Foresee taste by changing ratio of blends

③Easy understanding of new product taste for buyers

④Propose space management by taste

⑤R&D by collaborating with POS data

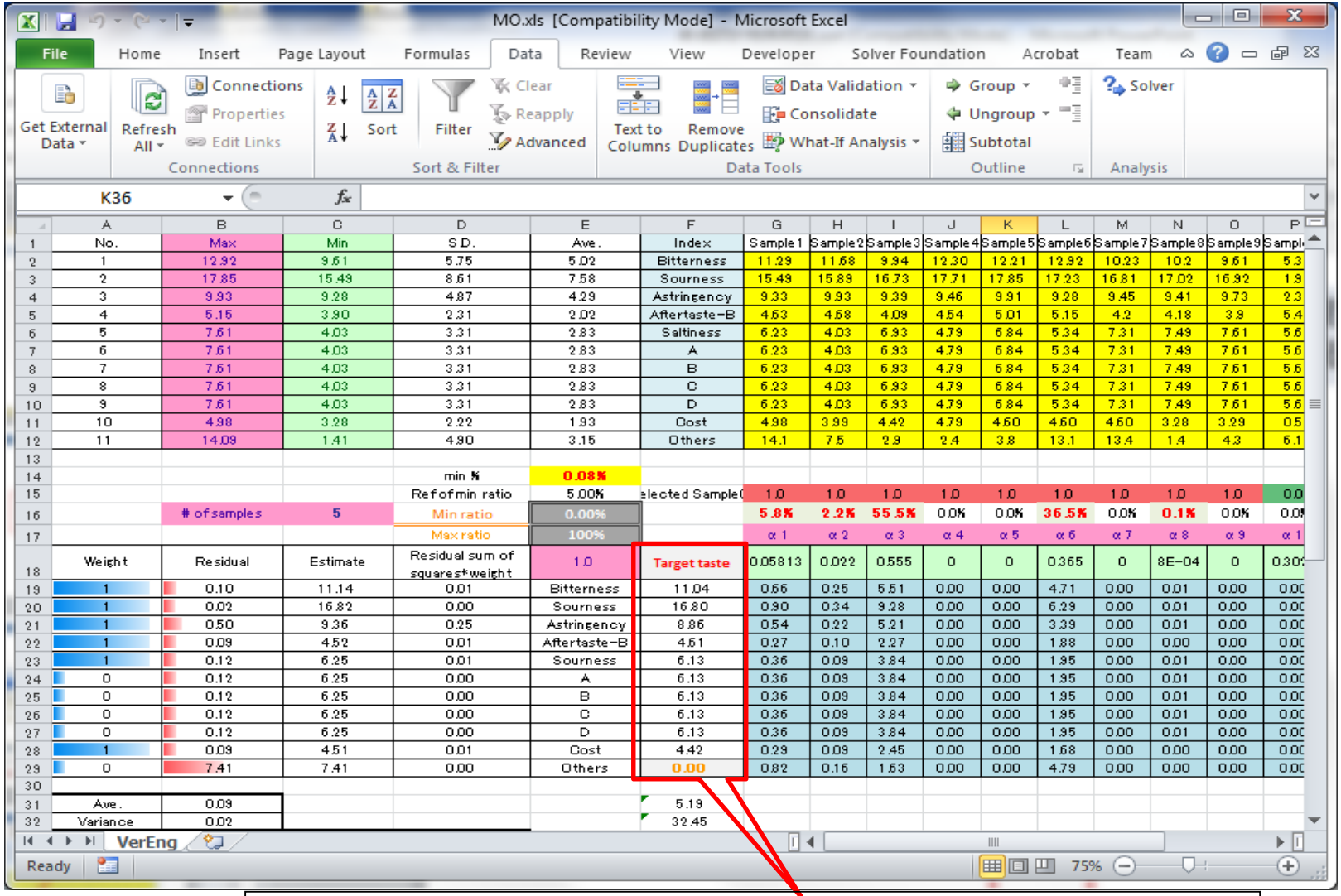
Mathematical Optimization

✓At first, installation of Excel® add-in Solver is required.

Step 1	• Select a target product and measure it using the Taste Sensing System • Enter the results into the Excel sheet
Step 2	• Measure raw materials for product design using the Taste Sensing System • Enter the results into the Excel sheet
Step 3	• Calculate the Mathematical Optimization
Step 4	• Blend raw materials based on the result and perform fine-tuning by a human sensory test if needed.

Step1

- Measure a target product using the Taste Sensing System.
- Enter the result into the Excel sheet.

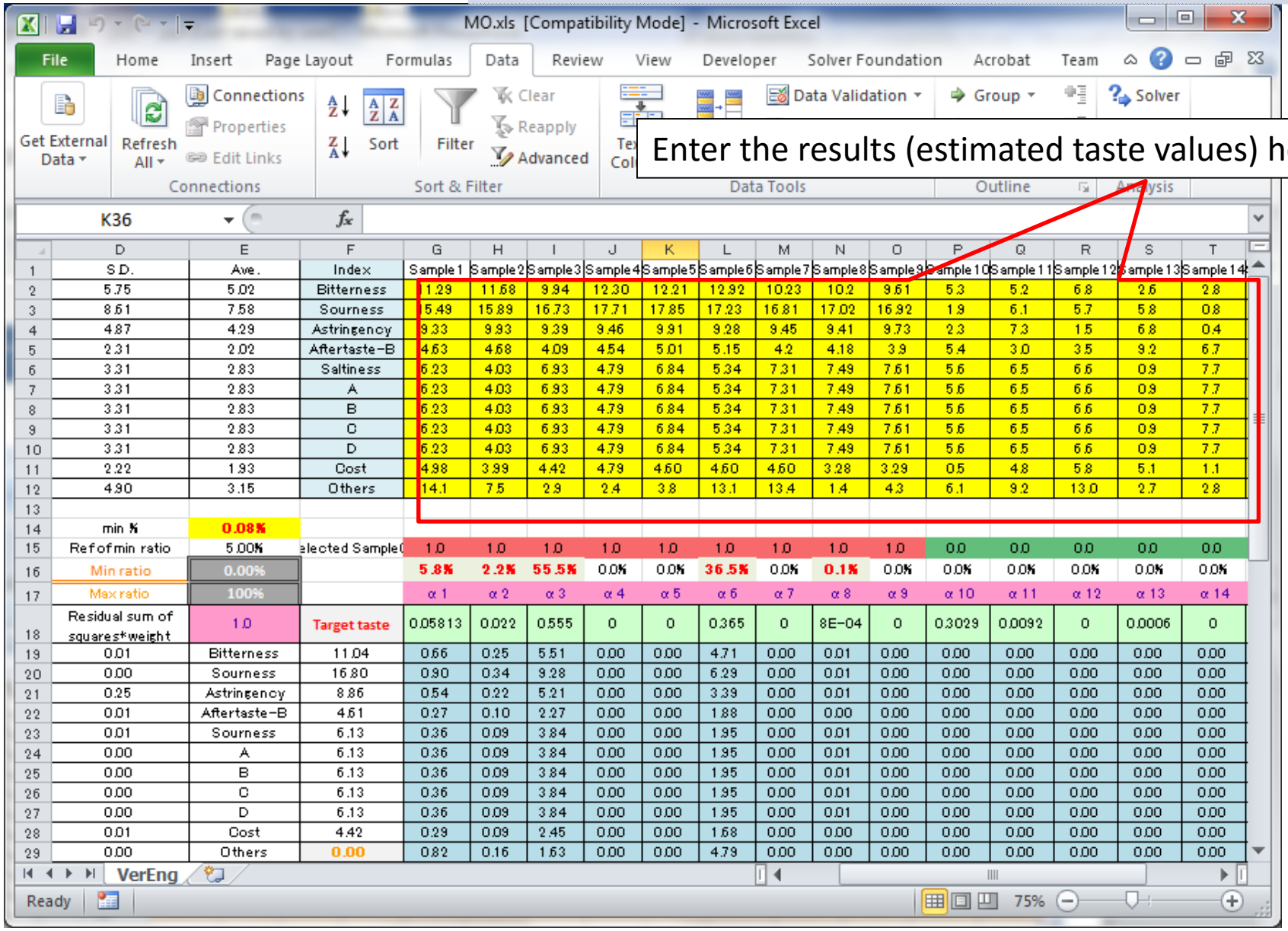


Enter the measurement result (estimated taste values) here.

COFFEE LABORATORY WHITE STONE VA 22578 TEL (804) 435-5522
www.coffeelabequipment.com

Step 2

- Measure raw materials for product design.
- Enter the results into the Excel sheet.



	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	S.D.	Ave.	Index	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13	Sample 14
2	5.75	5.02	Bitterness	1.29	11.68	9.94	12.30	12.21	12.92	10.23	10.2	9.61	5.3	5.2	6.8	2.6	2.8
3	8.61	7.58	Sourness	15.49	15.89	16.73	17.71	17.85	17.23	16.81	17.02	16.92	1.9	6.1	5.7	5.8	0.8
4	4.87	4.29	Astringency	9.33	9.93	9.39	9.46	9.91	9.28	9.45	9.41	9.73	2.3	7.3	1.5	6.8	0.4
5	2.31	2.02	Aftertaste-B	4.63	4.68	4.09	4.54	5.01	5.15	4.2	4.18	3.9	5.4	3.0	3.5	9.2	6.7
6	3.31	2.83	Saltiness	6.23	4.03	6.93	4.79	6.84	5.34	7.31	7.49	7.61	5.6	6.5	6.6	0.9	7.7
7	3.31	2.83	A	6.23	4.03	6.93	4.79	6.84	5.34	7.31	7.49	7.61	5.6	6.5	6.6	0.9	7.7
8	3.31	2.83	B	6.23	4.03	6.93	4.79	6.84	5.34	7.31	7.49	7.61	5.6	6.5	6.6	0.9	7.7
9	3.31	2.83	C	6.23	4.03	6.93	4.79	6.84	5.34	7.31	7.49	7.61	5.6	6.5	6.6	0.9	7.7
10	3.31	2.83	D	6.23	4.03	6.93	4.79	6.84	5.34	7.31	7.49	7.61	5.6	6.5	6.6	0.9	7.7
11	2.22	1.93	Cost	4.98	3.99	4.42	4.79	4.60	4.60	4.60	3.28	3.29	0.5	4.8	5.8	5.1	1.1
12	4.90	3.15	Others	14.1	7.5	2.9	2.4	3.8	13.1	13.4	1.4	4.3	6.1	9.2	13.0	2.7	2.8
13																	
14	min %	0.08%															
15	Ref.of min ratio	5.00%	elected Sample(	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
16	Min ratio	0.00%		5.8%	2.2%	55.5%	0.0%	0.0%	36.5%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
17	Max ratio	100%		α 1	α 2	α 3	α 4	α 5	α 6	α 7	α 8	α 9	α 10	α 11	α 12	α 13	α 14
18	Residual sum of squares*weight	1.0	Target taste	0.05813	0.022	0.555	0	0	0.365	0	8E-04	0	0.3029	0.0092	0	0.0006	0
19	0.01	Bitterness	11.04	0.66	0.25	5.51	0.00	0.00	4.71	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	Sourness	16.80	0.90	0.34	9.28	0.00	0.00	6.29	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
21	0.25	Astringency	8.86	0.54	0.22	5.21	0.00	0.00	3.39	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
22	0.01	Aftertaste-B	4.61	0.27	0.10	2.27	0.00	0.00	1.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.01	Sourness	6.13	0.36	0.09	3.84	0.00	0.00	1.95	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	A	6.13	0.36	0.09	3.84	0.00	0.00	1.95	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	B	6.13	0.36	0.09	3.84	0.00	0.00	1.95	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	C	6.13	0.36	0.09	3.84	0.00	0.00	1.95	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	D	6.13	0.36	0.09	3.84	0.00	0.00	1.95	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
28	0.01	Cost	4.42	0.29	0.09	2.45	0.00	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	Others	0.00	0.82	0.16	1.63	0.00	0.00	4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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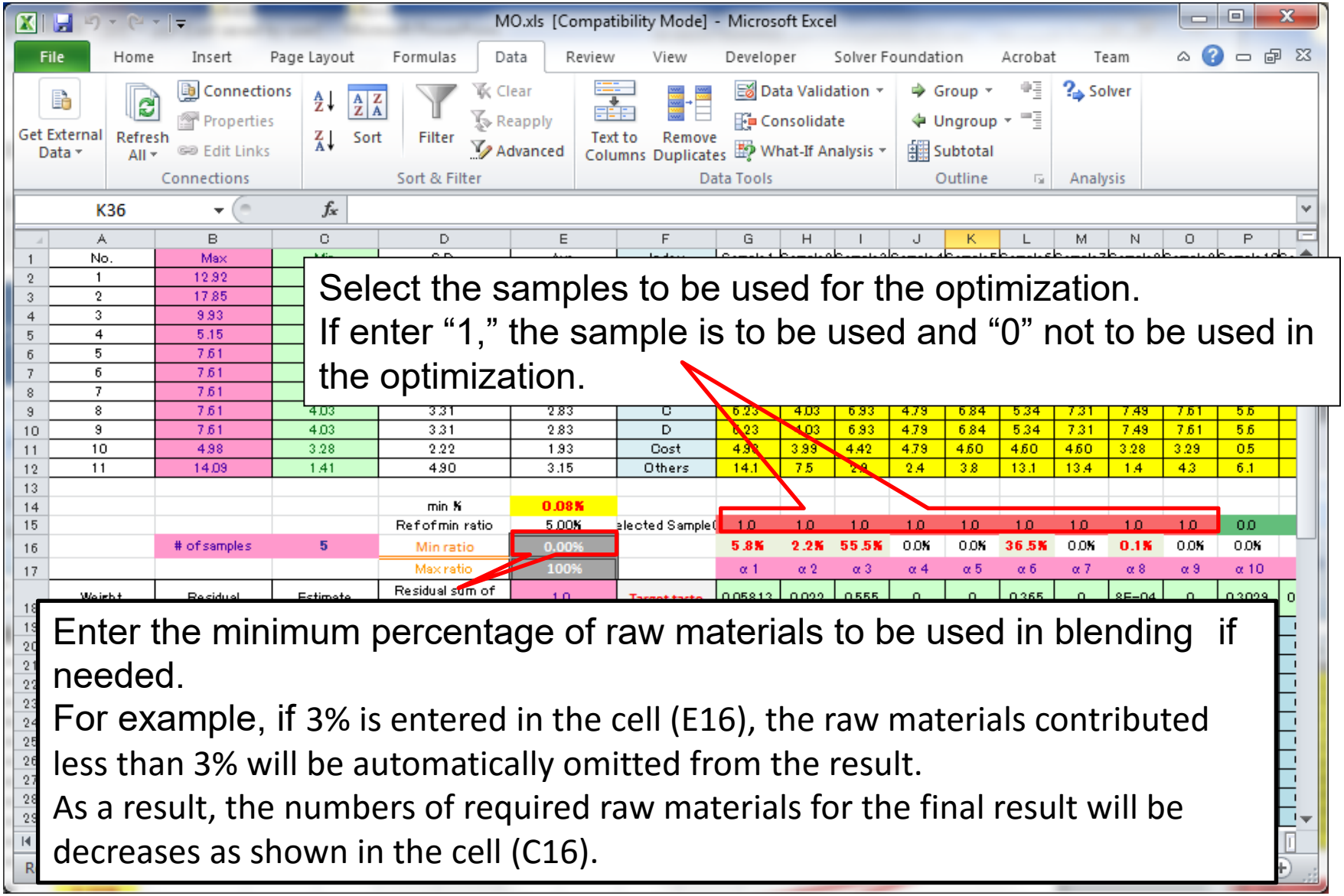
Step 3-1

- Calculate the Mathematical Optimization: setting options



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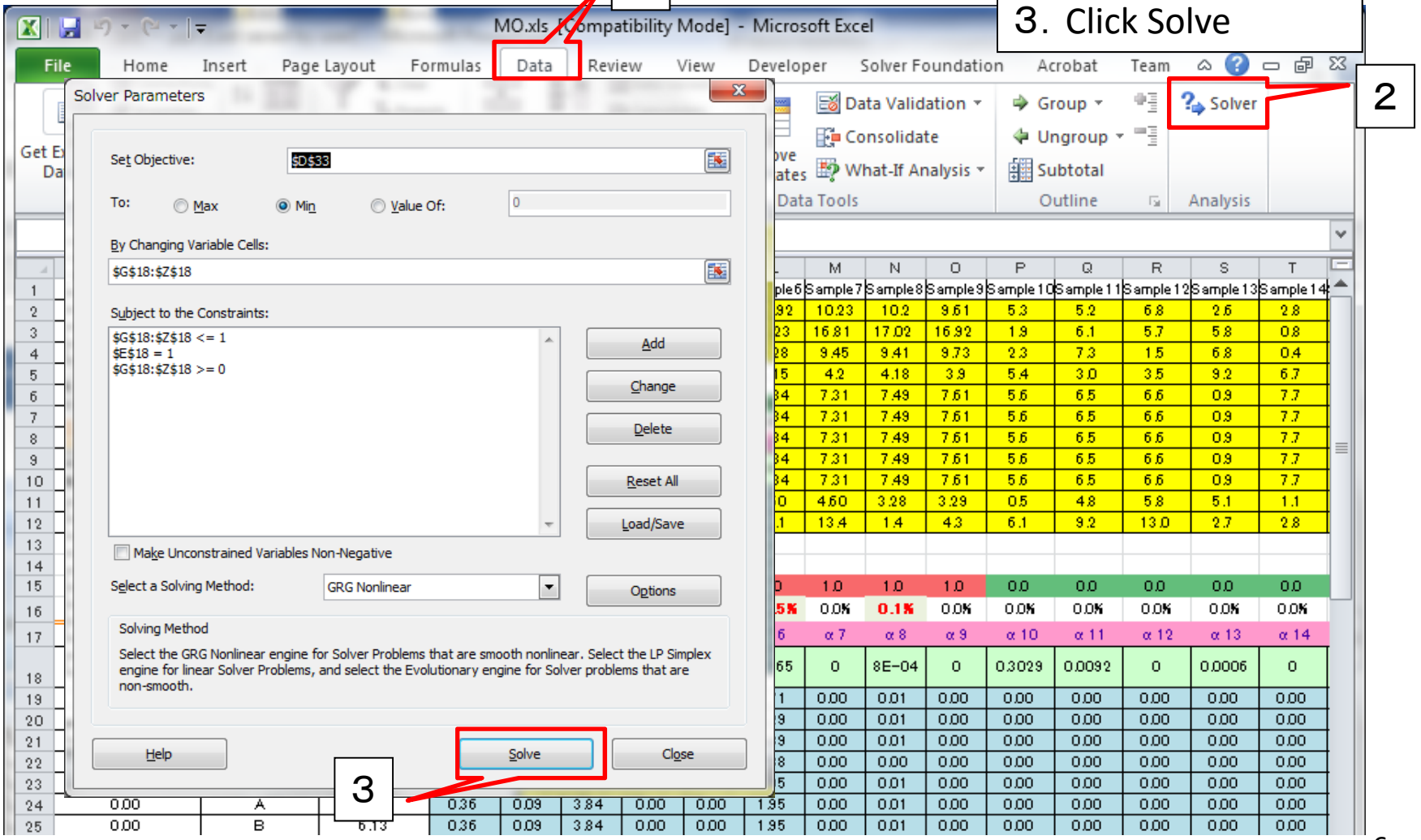
Step 3-2

- Calculate the Mathematical Optimization

1. Click the Data tab
2. Click Solver
3. Click Solve



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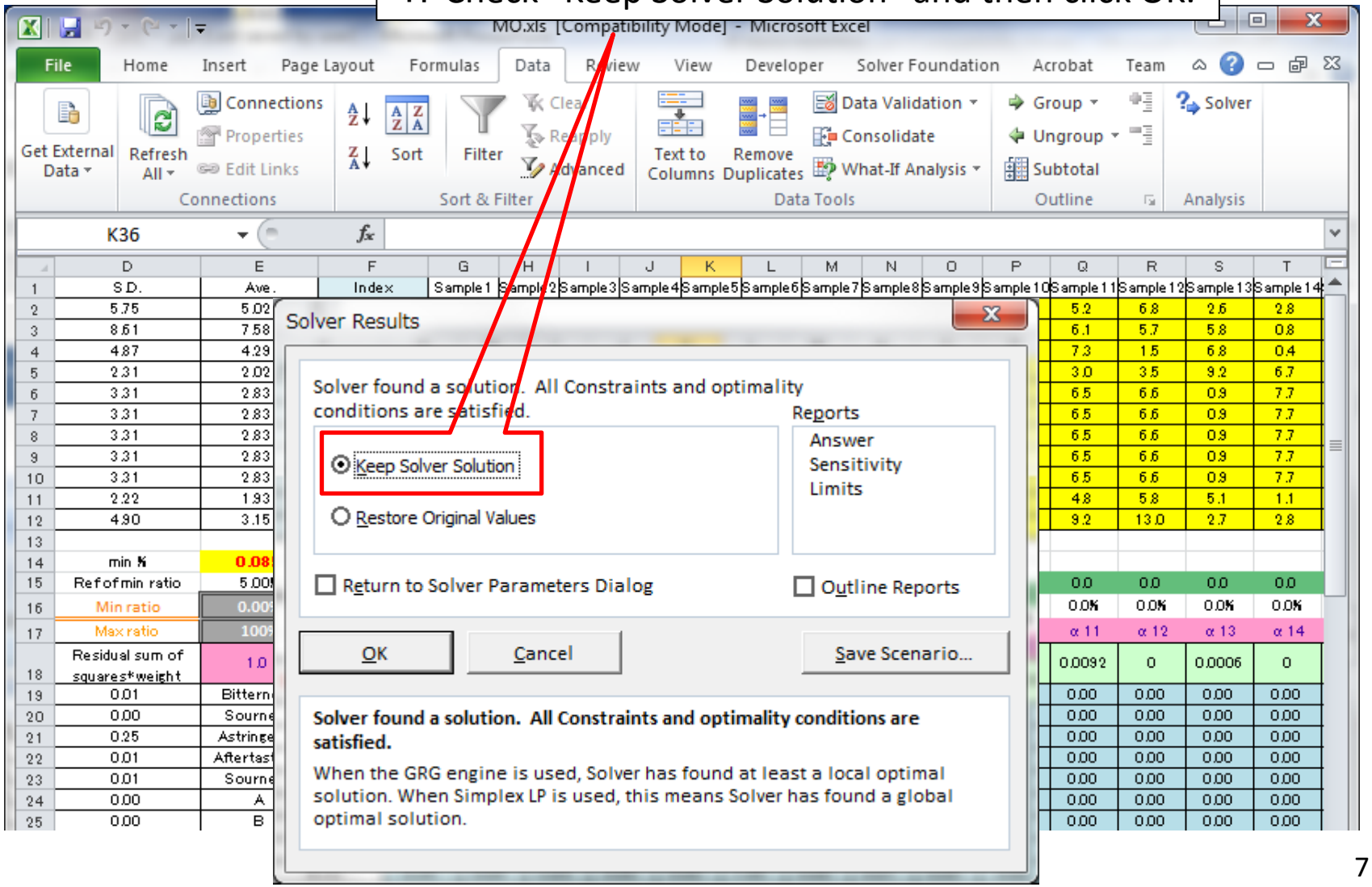
Step 3-3

- Calculate the Mathematical Optimization

4. Check “Keep Solver Solution” and then click OK.



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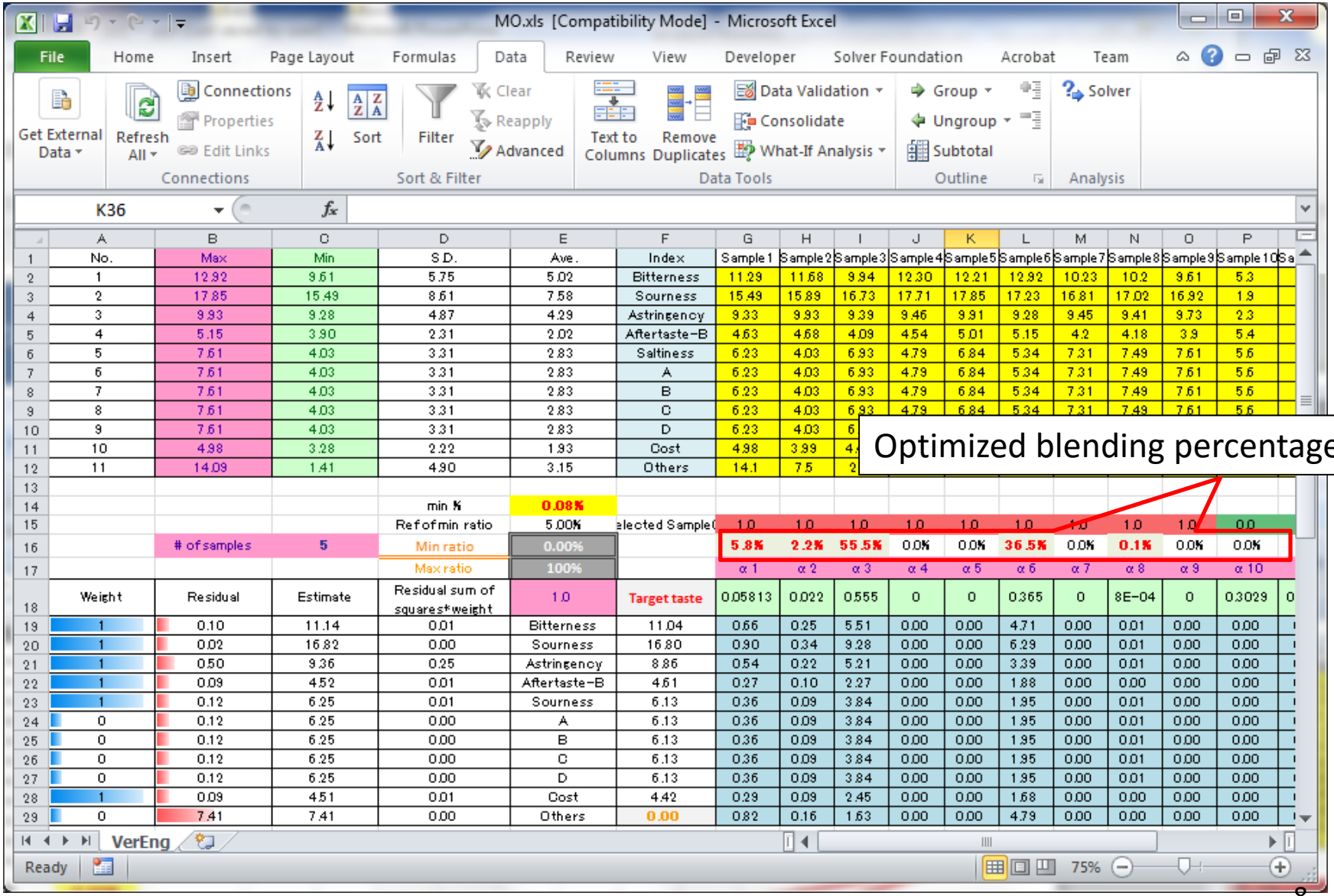
Step 4

- Blend the raw materials based on the calculated result and perform a human sensory test if needed.



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