

# Application News

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Physical Measurement  
Gas Chromatography Mass Spectrometry  
Liquid Chromatography Mass Spectrometry

## Total Quality Evaluation of Plant-based Meat

### ■ Introduction

With heightening interest in sustainable and healthy diet lifestyles, plant-based meat is getting more and more attention these days. As demand increases for developing new products of plant-based meat, there is a corresponding focus on the flavor quality of the products. However, it is sometimes difficult to precisely evaluate flavor that includes taste and aroma because highly complex combinations of numerous chemical compounds may define these factors. Widely-targeted analysis of the metabolites and aromatic compounds is one great idea to accomplish this evaluation.

LC-MS and GC-MS are suitable for the analysis of hydrophilic metabolites and volatile compounds related to taste, respectively.



As everyone knows, it's not just the taste and aroma that can define the quality of foods. Texture assessment is an essential parameter for evaluating food quality, especially when discussing meat-mimicking products. Material testers with appropriate jigs can clarify the properties related to the texture, such as hardness. Taste, aroma, and texture are independent factors and, therefore, should be discussed separately. However, we sometimes want to rate the "total quality" of the food products. Multivariate analysis can visualize the "distance" of each sample regarding all these factors. Coming to this assessment, the ambiguous term "quality" could be concretely and comprehensively solidified from the point of view of the influential factors that foods inherently have.

Here, we introduce the result of four different plant-based meat products with this quality evaluation approach.



### ■ Sample Preparation

We prepared four different commercially available plant-based meat products (Product 1 to 4). They are all substitutes for ground beef. They were cooked before analysis.







### ■ Multivariate Analysis

We summarized the data, including LC-MS, GC-MS and Material Tester analysis, for principal component analysis. All the data were summarized in one table (Fig. 5). The values in the tables are the peak areas in LC-MS / GC-MS analysis, and force intensities in the Material Tester, respectively. These values are then standardized with their average and standard deviation not to get biased in rows that have a different order of absolute values.

The resulting score plot from principal component analysis is shown in Fig. 6. The score plot can be interpreted as the “total similarity” of each sample, pertaining to the taste, aroma and texture. The more the pattern of the data are alike, the closer the dots of the samples get to each other. This allows us to review the similarity of each sample without any subjective factors.

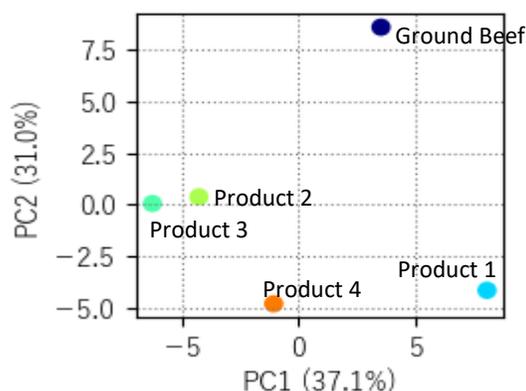


Fig. 6: Score plot of the result from principal component analysis

Experiment	Title	Ground Beef	Product 1	Product 2	Product 3	Product 4
LC-MS (Metabolites)	Cystine	0.00	5133.67	0.00	0.00	0.00
	Asparagine	3233.33	4662.67	5600.67	8911.00	5485.00
	Aspartic acid	8942.67	25824.67	11168.33	26395.33	12748.00
	⋮	⋮	⋮	⋮	⋮	⋮
LC-MS (Sugars)	Sucrose	24.16	82.57	51.60	1.91	2718.60
	Maltose	7.15	18.74	5.77	1.20	161.06
	Lactose	8.35	25.02	18.52	0.99	67.78
	⋮	⋮	⋮	⋮	⋮	⋮
GC-MS	l-Alanine ethylamide	3800125.00	3194828.67	3535825.67	3851375.67	3674014.00
	Acetic acid	11625.00	10922.33	12232.00	11354.33	10993.33
	cis-4,5-Epoxy-(E)-2-decenal	28785.00	28580.33	39956.67	48981.33	39483.33
	⋮	⋮	⋮	⋮	⋮	⋮
Material Tester	Max Force	16.37	16.76	12.71	13.11	12.55
	Time when Max Force	1.42	1.28	1.04	1.21	0.87
	Stroke when Max Force	14.17	12.83	10.40	12.10	8.67

Fig. 5: All the data from each experiment were summarized in the same table for carrying out the multivariate analysis. The values are before standardization. Totally 94 sets (rows) of data were simultaneously analyzed.

### ■ Conclusion

Our LC-MS, GC-MS and Material Tester have the possibility to assess the total quality of plant-based meat products, including taste, aroma and texture, respectively. Moreover, combining these data allows us to evaluate the total quality of the product. This strategy is not only for plant-based meat but also available for all food product quality.

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