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Nutrition and Sustainability:

Developing an Optimization Strategy Tool for Procurement and Consumption of Food Ingredients with Consideration of Nutritional Value and Carbon Footprint

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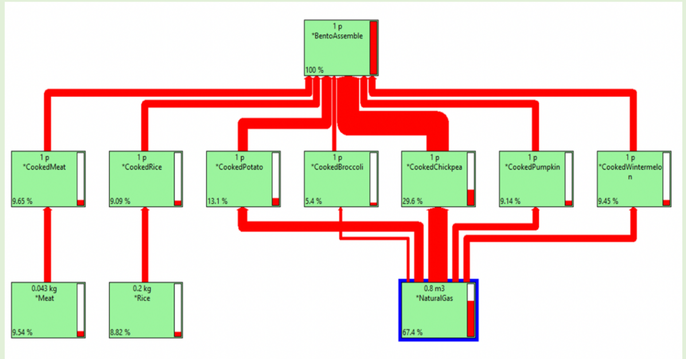
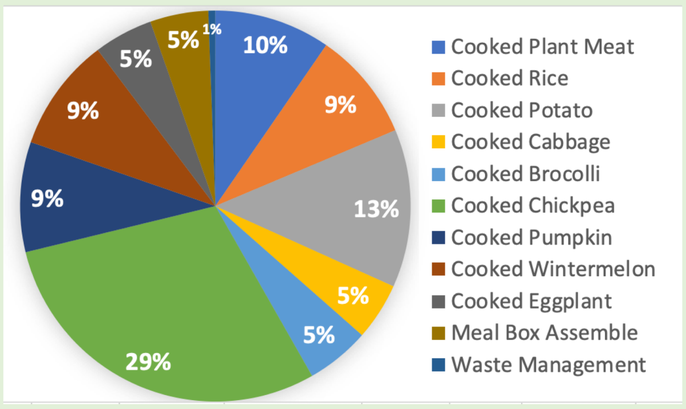
1) The carbon footprint and nutritional values of each ingredient varies.

This study initially developed a 'Vegetarian Meal Box Carbon Footprint Calculation Tool' referred to the 'PCR for Meal Box Products ', using a vegetarian meal box manufacturer in Taiwan as the data source.

The carbon footprint of each dish and each ingredient varies, and they also possess different nutritional values.

If the subsequent production involves creating 'low-carbon vegetarian meal box' products, besides minimizing the carbon footprint of ingredient sourcing, it's also essential to consider whether each ingredient provides sufficient nutritional content to meet human dietary needs.





*The results are calculated using SimaPro

2) Establishing a database that integrates the nutritional composition and carbon footprint of various ingredients.

The nutritional information for each ingredient is sourced from the Food and Drug Administration, Ministry of Health and Welfare, Taiwan.

The carbon footprint data for each ingredient is sourced from multiple databases, including the Taiwan Environmental Protection Administration's Product Carbon Footprint Information Network, the CLCD database, and Ecoinvent 3.

Ingredients	Calorie (kcal)	Calorie (kcal)	Protein (g)	Fat (g)	Carbon-hydrate (g)	fiber (g)	Carbon footprint (kg)	Carbon footprint database
Wheat flour (Average)	359	342	13.0	1.7	71.4	8.0	0.000317	Wheat flour mix {GLO}| market for wheat flour mix | Cut-off, U
Rice (Average)	354	352	7.0	0.7	77.8	0.7	5.01E-07	Rice, dried, market mix, at regional storage {US} Economic, U
Potato (Average)	77	74	2.6	0.2	15.8	1.3	0.000151	Potato {GLO}| market for potato | Cut-off, U
Papaya (Average)	38	36	0.6	0.1	9.9	1.4	0.0000173	Papaya {GLO}| market for papaya | Cut-off, U
Banana (Average)	85	82	1.5	0.1	22.1	1.6	0.0000581	Banana {GLO}| market for banana | Cut-off, U
Pineapple (Average)	53	51	0.7	0.1	13.6	1.1	0.0000116	Pineapple {GLO}| market for pineapple | Cut-off, U
Strawberry (Average)	39	36	1.0	0.2	9.3	1.8	0.0000573	Strawberry {GLO}| market for strawberry | Cut-off, U
Mango (Average)	56	54	0.6	0.2	14.4	1.1	0.0000313	Mango {RoW}| market for mango | Cut-off, U
Peach (Average)	39	37	0.9	0.2	9.7	1.7	0.000173	Peach {GLO}| market for peach | Cut-off, U

3) Calculate the total nutritional requirements based on the diners' gender and age.

This poster is taking a hypothetical scenario of a staff canteen with 60 diners.

The age and gender distribution is as follows:
25 males aged 19-30; 20 males aged 31-50; 7 males aged 51-70;
30 females aged 19-30; 15 females aged 31-50; 3 females aged 51-70.

The information on human dietary nutritional requirements is derived from the Dietary Reference Intakes (DRIs) proposed by the Health Promotion Administration, Ministry of Health and Welfare, Taiwan in 2022.

Gender	Age	Calorie (kcal)	Protein (g)	Carbonhydrate (g)	Carbohydrates/ Total energy intake (%)	fiber (g)	Fat/ Total energy intake (%)	Diner
Male	19-30 (lower limit) (upper limit)	2400 2700	70	130	50 65	34	20 30	25
	31-50 (lower limit) (upper limit)	2400 2650	70	130	50 65	34	20 30	20
	51-70(lower limit) (upper limit)	2250 2500	70	130	50 65	32	20 30	7
Female	19-30 (lower limit) (upper limit)	1900 2100	60	130	50 65	27	20 30	30
	31-50 (lower limit) (upper limit)	1900 2100	60	130	50 65	27	20 30	15
	51-70(lower limit) (upper limit)	1800 2000	60	130	50 65	25	20 30	3
Lower limit of nutritional requirements		214650	6520	13000	50	3044	20	
Upper limit of nutritional requirements		238500			65		30	

These nutritional requirements establish clear procurement and cooking standards for the supplier of corporate meals.

4) Output the optimal strategy to meet human nutritional requirements while minimizing carbon emissions.

Database — Nutritional composition and carbon footprint of various ingredients

Variables — Various ingredients

Constraints — The lower and upper limit of nutritional requirements

Objective — Minimize the total carbon footprint

5) Research Progresses and Discussions

- This study has currently only incorporated the carbon footprint database from Ecoinvent 3. It utilizes the OpenSolver tool in Microsoft Excel for optimization analysis.
- The interim results indicate that the optimal dietary strategy includes consuming 300g of japonica rice, 700g of pineapple, 1000g of cucumber, 700g of zucchini, 25g of butter, 50g of vegetable oil, and 150g of tofu daily. Further adjustments to these results are still pending.
- During the iterative process of optimization, the model consistently recommends the consumption of soy milk, tofu, and other soy products. It can be roughly estimated that soy products serve as excellent low-carbon protein sources.

5) Conclusions and Future Works

- This study aims to establish a database that integrates the nutritional composition and carbon footprint of various ingredients. It further aims to develop a tool capable of calculating the optimal strategy to meet human nutritional requirements while minimizing carbon emissions.
- Through such a tool, the food supply chain can manage resources more effectively, optimize ingredient procurement and utilization. This contributes to advancing the development of sustainable food supply chains and promoting the food industry towards a more environmentally friendly and sustainable direction.
- Consumers are becoming more aware of their food choice's environmental and social impact and are seeking sustainable products. Meeting consumer demand for sustainable food products can help to build brand reputation, increase customer loyalty, and improve market share.

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