8th IFDC International Food Data Conference 2009

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Using Nonlinear Programming to Develop Recipes for Complementary Food

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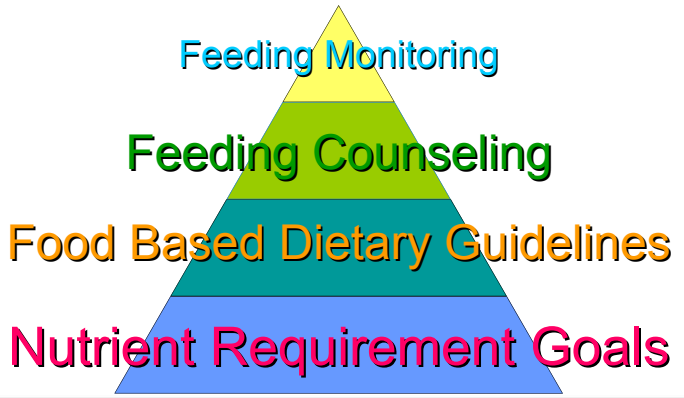
Background

- Poor complementary feeding (CF) is the common cause of most growth faltering occurred during the weaning age.
- Optimal CF recommendation for Thai infant and young child (IYC) was developed by Thai IYC Feeding Guides working group in 2008.

Improving for Complementary Feeding Quality



Nutrient Goals for CF

CF = DRI* – Breast Milk**

* DRI-THAI 2003

** Average breast milk volume of devloping countries x Nutrients content (WHO, 1998)

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Nutrient Goals for CF

AGE Group	DATA Source	Energy Kcal/d	Protein g/d	VA µg RE/d	Folate µg/d	B2 mg/d	B1 mg/d	VC mg/d	Ca mg/d	Iron mg/d	Zn mg/d
6-8 mo.	DRI THAI 2003	632	12.5	400	80	0.4	0.3	35	270	9.3	3
	Breast Milk	413	7.1								
	Target for CF	219	5.4	63	22.7	0.2	0.20	8	81.3	9.1	2.2
9-11 mo.	DRI THAI 2003	702	14.4	400	80	0.4	0.3	35	270	9.3	3
	Breast Milk	379	6.5								
	Target for CF	323	7.9	92	27.6	0.2	0.20	10.4	97.5	9.1	2.3
12-17 mo.	DRI THAI 2003	797	14	400	150	0.5	0.5	40	500	5.8	2
	Breast Milk	346	5.8								
	Target for CF	451	8.2	125.5	103.3	0.3	0.40	18	346.3	5.6	1.3
18-23 mo.	DRI THAI 2003	902	14.3	400	150	0.5	0.5	40	500	5.8	2
	Breast Milk	346	5.8								
	Target for CF	556	8.5	125.5	103.3	0.3	0.40	18	346.3	5.6	1.3

Objectives

- This study aimed to develop CF recipes for Thai IYC, age 6-8, 9-11 and 12-23 months old which meet the Thai Dietary Recommended Intakes (DRI) 2003.
- Optimal caloric distribution.
- Optimal energy density.

Method 1

- The Mathematical model was designed to included calculation of macronutrients and concerned micronutrients from Thai food composition database, consumption size of ingredients, and no. of meal.
- The excel solver nonlinear programming was used for solving the optimal solution to meet the energy goal.
- Other nutrient goals (≥70% of CF goals), range of the ingredients consumption size in each recipe.

Method 2

- Energy density (≤1.0 Kcal/g) and optimal range of caloric distribution were the constraints.
- Three different recipes for each age group were setup from popular ingredients which common be cooked for infant and young child.
- All recipes were solved to find the optimal portions of the ingredients by the solver function in excel program.

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Food based portions

- **Household unit** :- Big spoon (Bsp),
- Table spoon (Tbs), Tea spoon (Tsp)
- **Natural unit** :- ½ egg, 1banana, 2 oranges
- **Container-packaging unit** :- cup, box, blow



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The Mathematical model was designed to included calculation of macronutrients and concerned micronutrients from consumption size of ingredients

Congee with yolk andivy gourd										
3/15/2009	6-8 month		Portion	Wt/Portion(g)	No.Portion	Include	Wt	PROA	PROV	CHO
Ingredients				(g)			(g)	g	g	g
ข้าวสวย	01015	ข้าวเจ้า, ขัดขาว, นึ่ง	ช้อนกินข้าว	10	4	1	40.0	0.0	0.9	12.1
ปลายข้าวสาร	01083	ปลายข้าวสาร, ข้าวเจ้า	ช้อนกินข้าว	15	1	0	0.0	0.0	0.0	0.0
โจ๊กขัน	01107	โจ๊ก, เปล่า, ขันหนืด	ช้อนกินข้าว	16	3	0	0.0	0.0	0.0	0.0
โจ๊กขันปานกลาง	01089	โจ๊ก, เปล่า, ขันปานกลาง / ปลายข้าวสาร, ข้าวเจ้า, ต้ม	ช้อนกินข้าว	16	4	0	0.0	0.0	0.0	0.0
น้ำแกงจืดซุปขาตั้งหมู	20038	น้ำแกงจืด, ขาตั้งหมู / น้ำซุป, ขาตั้งหมู	ช้อนกินข้าว	10	10	1	100.0	0.7	0.0	0.1
น้ำมัน	10004	น้ำมันถั่วเหลือง	ช้อนชา	5	0.5	1	2.5	0.0	0.0	0.0
ไข่	08011	ไข่ไก่, ทั้งฟอง	ฟอง	50	0	0	0.0	0.0	0.0	0.0
ไข่แดง	08015	ไข่ไก่, ไข่แดง	ฟอง	14	0.5	1	7.0	1.0	0.0	0.1
เนื้อหมู	06068	หมู, เนื้อ, สันนอก	ช้อนกินข้าว	15	1	0	0.0	0.0	0.0	0.0
หมูสับ	06086	หมู, สับ	ช้อนกินข้าว	15	1	0	0.0	0.0	0.0	0.0
เนื้อไก่	06008	ไก่, เนื้อ	ช้อนกินข้าว	15	1	0	0.0	0.0	0.0	0.0

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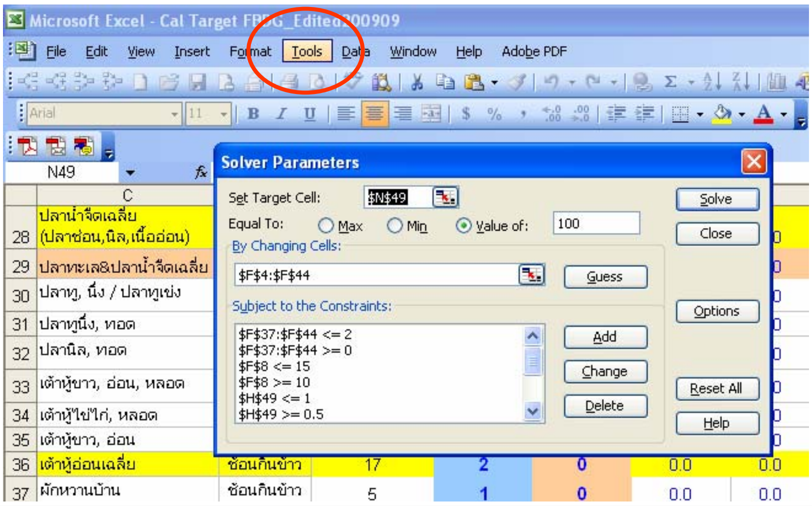
The excel solver nonlinear programming was used for solving the optimal solution to meet the energy goal.



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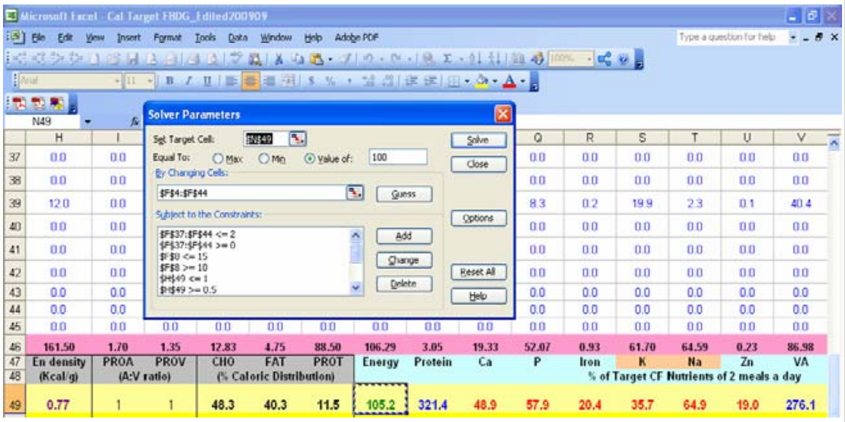

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Nutrients content per serving of example recipes for 3 age group

Amount from Recipes per meal	Energy	Protein	Ca	Iron	Na	Zn	VA	B1	B2	VC
	Kcal	g	mg	mg	mg	mg	RE	mg	mg	mg
6-8 month										
Congee+yolk+ivy gourd	106.3	3.1	19.3	0.9	64.6	0.2	87.0	0.0	0.1	1.6
Congee+tofu+spinach	105.9	4.0	28.2	1.1	69.2	0.4	453.1	0.1	0.1	12.6
Congee+mackerel+pumkin	105.3	4.7	29.0	0.7	165.0	0.1	13.3	0.0	0.0	1.4
Average	**105.8**	**3.9**	**25.5**	**0.9**	**99.6**	**0.3**	**184.4**	**0.0**	**0.1**	**5.2**
9-11 month										
Boiled rice+egg+ivy gourd	109.6	4.3	20.5	1.1	85.3	0.3	114.5	0.0	0.1	2.1
Boiled rice+seapearch+carrot	109.3	6.3	19.7	0.6	87.5	0.1	30.6	0.0	0.1	3.8
Boiled rice+mince pork+spinach	119.3	4.9	8.7	2.3	99.4	0.1	29.3	0.2	0.0	16.8
Average	**112.7**	**5.1**	**16.3**	**1.3**	**90.8**	**0.2**	**58.1**	**0.1**	**0.1**	**7.6**
12-23 month										
Fry rice+egg+chicken-pumkin soup	200.1	7.9	18.5	1.5	109.6	0.4	506.0	0.1	0.3	18.8
Rice +fry tofu+mince pork-blood-carrot soup	196.3	8.3	44.5	4.6	152.2	0.5	103.3	0.2	0.1	5.9
Rice+fry mackerel+egg-potato-radish soup	187.5	8.5	45.0	2.0	225.5	0.6	99.2	0.1	0.2	10.8
Average	**194.6**	**8.2**	**36.0**	**2.7**	**162.4**	**0.5**	**236.2**	**0.1**	**0.2**	**11.9**

Portion, density and Caloric distribution per serving of example recipes for 3 age group

Recipes	Total weight	PROA	PROV	FAT	Energy density	PROA	PROV	CHO	FAT	PROT
	g	g	g	g	(Kcal/g)	(A:V ratio)		(% Caloric Distribution)		
6-8 month										
Congee+yolk+ivy gourd	137.3	1.7	1.4	4.8	0.77	1.3	1.0	48.3	40.3	11.5
Congee+tofu+spinach	160.0	2.0	2.1	3.9	0.66	1.0	1.0	51.7	33.1	15.2
Congee+mackerel+pumkin	144.1	3.6	1.1	3.3	0.73	3.3	1.0	52.8	27.9	18.0
Average	**147.1**	**2.5**	**1.5**	**4.0**	**0.72**	**1.83**	**1.00**	**50.94**	**33.73**	**14.88**
9-11 month										
Boiled rice+egg+ivy gourd	148.8	2.8	1.5	4.4	0.74	1.9	1.0	47.8	36.4	15.7
Boiled rice+seapearch+carrot	157.3	5.0	1.2	3.1	0.70	4.0	1.0	50.7	25.5	22.9
Boiled rice+mince pork+spinach	147.9	3.9	0.9	5.2	0.81	4.2	1.0	44.1	39.5	16.3
Average	**151.3**	**3.9**	**1.2**	**4.3**	**0.75**	**3.39**	**1.00**	**47.55**	**33.81**	**18.32**
12-23 month										
Fry rice+egg+chicken-pumkin soup	196.1	6.2	1.7	9.0	0.96	3.7	1.0	44.0	40.3	15.7
Rice +fry tofu+mince pork-blood-carrot soup	223.6	5.0	3.4	8.6	0.83	1.5	1.0	43.7	39.3	17.0
Rice+fry mackerel+egg-potato-radish soup	203.6	6.4	2.1	6.8	0.87	3.0	1.0	48.9	32.8	18.1
Average	**207.8**	**5.9**	**2.4**	**8.1**	**0.89**	**2.74**	**1.00**	**45.52**	**37.43**	**16.95**

Results 1

- Mean energy of 9 solved CF recipes was 107±4.1% of the goal.
- Most of other nutrient goals, except Ca and Zn, were met.
- Protein, K, Na and most of vitamins were above 100% of CF nutrient goals.

Results 2

- P, Fe and vitamin B1 were above 70%. When the recipes combined with breast milk, only Zn content was still lower than target (44.3±17.2%DRI).
- Caloric distribution was in optimal range.

  Carbohydrate : Protein : Fat

  = 48.0±3.4 : 16.7±3.0 : 35.0±5.5)
- Average energy density was 0.8±0.1 Kcal/g.

Conclusions

- Zn might be a “Problem Nutrient”.
- The nutrient retention factors had not been included in the model, so some micronutrients might be overestimated.
- The outcome of the study is demonstrated in the “Manual of complementary feeding”.

Further step

- The excel solver able to solve this recipe calculation model within seconds. So the model has possibility to develop to be friendly diet calculation for individual counseling.
- The program for supporting health personnel to evaluate and suggest CF feeding based on favorite foods of each child are plan to develop by combine this solver function combine with the simple score unit.

Nutrient Score System

The meal quality goals in nutritive values format are too difficult to use for non-nutrition back ground persons. The simple score unit developed for school lunch menu management program was developed. (present in ICN 2009)

Criteria of nutrients quality levels for simple recipe evaluation

Nutrients	Quality level				
	should improve	quite poor	fair	good	Very good
Macro-nutrients (Energy, Protein, Fat)	< 9	9	10	11	12
Dietary fiber	< 7	7-8	9-10	11	12
Vitamins & Minerals	< 7	7-8	9-10	11	12

Quality Food Composition Data : Key for Improving Infant and Young Child Feeding

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