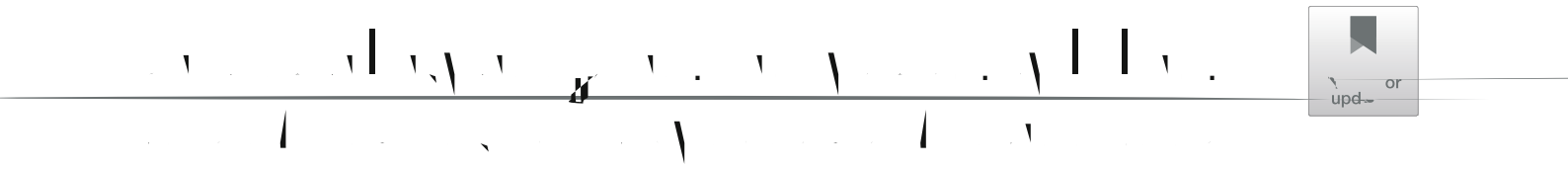
or
upd

B

and most micronutrients. Lastly, Excel Solver was utilized to produce the linear programming model.

Before running the program, the details of each macronutrient and micronutrient of food items, price per serving size, were filled in Microsoft Excel. The next step was setting up the constraints in the model such as upper bound (UL) and lower bound (LB) for energy, macronutrients and micronutrients. Excel Solver was later used to determine the optimal foods portion size that met all the dietary and nutrient recommendation of WCRF/AICR 2007 [20], MDG 2010 [21] and RNI 2017 [19] with the lowest possible cost. From the suggested foods portion, a daily balanced menu was later planned The optimization model will be repeated several times to produce two more suggested palatable menus with the lowest possible costs.

Cancer prevention diet models with the lowest cost were planned. The formulation for Linear Programming is as follows:

$$\text{Minimize} : z = \sum c_j x_j$$

2 C js s r j C /A C , _D , \ j s j s

C s j	_B	B	_	_	_
C /A C 2007					
\ - s r j s (j /)	5	–	13	14.5	11.5
C s	–	–	6	3.5	6
	–	–	1	2	–
j s	–	–	4	6	3.5
r j s	–	–	2	3	2
ss (j /)	–	3.5	0	0	0
ss j s r s (j /)	1	–	2	2	5
j ( )	25	35	32.3	26	26.3
j- ( )	500	2000	563	1631	1853
_D 2010					
C s j s (j)	6	8	6.5	6	6
_ / r (j)	1	2	1	1	2
js (j)	1	3	1	1	2.5
_ r s (j)	0.5	1	1.5	1	1
j j					
j (j)	1	2		1	
j (j)	1	2		2	2
\ 2017					
E ( )	1600	2000	1802	1685	1889
j ( )	42	100	69.5	58	102
C s ( )	212	300	224	218	236
( )	38	68	62	59	56
C s ( )	60	200	135.7	116	217
r ( )	10	22	16.5	10.5	19.9
_ r s r ( )	22	33	23	19.8	23.6
r s r ( )	10	15	15	13.7	13.5
ssj- ( )	4700	10,000	4729	4696	4704
j j A (E)	600	3000	4826	1913	1409
B -C	2500	17,000	10,430	10,516	6365
j j E ( )	7.5	1000	12	10.2	13.2
j j (µ)	55	1000	55	71.6	99.7
j j C ( )	70	1000	549	233	274
j j B12 (µ)	4	23	11.5	7.3	6.6
(µ					

2 C js s r j C /A C , _D , N jj s j s (Continued)

C s j	_B	B	_	_	_
s r s ( )	700	4000	1370	1507	1608
r ( )	0	50	47	48	45

relationship between diet cost and diet quality in Western countries and to develop food-based dietary guidelines in developing countries where residents need to achieve nutritional requirement with their limited income of diet [28]. Similarly, a Malaysian study done by Rajikan et al. developed a healthy and palatable diet for low income women at the minimum cost based on Malaysian Dietary Guidelines 2010 and Recommended Nutrient Intake 2005 via linear programming [29]. Optimization models provide an elegant mathematical solution that can help to determine that a set of dietary guidelines is achieved by Malaysian population subgroups. There were three models produced by linear programming. Table 2 shows all nutrients constrains and the food groups of the three different models produced by LP based on the dietary guidelines of WCRF/AICR 2007, MDG 2010 and RNI 2017. The three models produced, fulfilled the upper and the lower limits of the constrains including macronutrient and micronutrient recommendations set by WCRF/AICR 2007 and RNI 2017, the serving size of the food groups based on WCRF/AICR 2007 and MDG 2010. The palatability factor was also considered by including servings from vegetable oil and palm oil.

Looking at the three LP models as shown in Table 2, iron, potassium and calcium only reached the lower limit of the constraint values. However, other nutrients such as carbohydrate (CHO), fat, vitamin A and fiber reached the upper limit of the maximum acceptable value of constraints.

The food list selected comprised mainly on fruits and vegetables with the highest serving, as complex mixture of phytochemicals present in whole vegetables and fruits may have additive and synergistic effects responsible for anti-cancer activities [6]. Beside, these food items are low-energy density and high in fibers, which will provide sufficient fibers to meet the recommendations of 25-g fibers by WCRF/AICR and meeting the new recommendation of RNI 2017 for potassium.

From the suggested food list of the models, it is understood that each model consisted of at least two servings of whole and unprocessed grains such as brown rice, oat, lentils, and whole meal bread, thus ensuring high fiber and nutrient contents. The food list for each model also provides at least two servings of fruits and more than nine servings of vegetables, although it resulted in slight variation of the existing diets. In consequence, an optimal cancer prevention menu is developed based on a model that was produced using a linear programming method where it meets the requirements of constraints based on the dietary guidelines of WCRF/AICR 2007, MDG 2010, and RNI 2017.

3 D s j r s j j j s

_	_ r 1	_ r 2	_ r 3
B s	j r (1 r) (1 s j)	_ s j s (1 j N j (1 r) r) j (1 r)	B (1 j)
_ j s	B r j r s (1 r)	j s (2 j s)	C C s (3 j s) C j (1 r)
r	B j (3s s) j j _ (1 jr j) j r j (1 r)	B s j j (3 s s) r 5((3)6.9( )-42.1(s.3((1)-295.7(r 3.3(j* 2 4((1 r s (7: 2)-295 268 D22(j)-297.3	

Table 3 shows the three menus produced, according to raw food items at the lowest possible cost based on WCRF/AICR, MDG, RNI and palatability constraints by

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