PRODUCT DEVELOPMENT

The criteria *for the product development of the maternal food supplement were as follows :*

1. *The product should be culturally acceptable to the target group i.e. pregnant and lactating women.*
2. *The sharing of the product by the family specially young children should be minimum.*
3. *Should be easy to prepare on a large scale.*
4. *Should bridge the nutrient gap (especially of calories and proteins) at least partially.*
5. *Should have a long shelf life.*
6. *Should be as close as possible in cost to that permissible for a daily maternal supplement in the ICDS.*

Based on the PFNDAI (1977) study, a biscuit with fenugreek flavour (methi biscuit) was the choice of product. Biscuits have been recommended as the food supplement for pregnant and lactating mothers by Gopalan (1985) and Prentice et al (1980), because firstly they have high energy density and secondly they can be consumed in addition to the habitual diets and have a minimum effect on the customary consumption of other foods. Besides, biscuits are a popular snack food in Gujarat. They can be produced at a reasonably low cost, can be manufactured in bulk, are easy to pack and distribute, have easy accountability and a comparatively long shelf life.

Methi (fenugreek) seed flavour was selected for two reasons :

1. *It imparts a characteristic bitter taste to the biscuits and therefore could make the biscuits less acceptable among children,*
2. *It is recognized for several medicinal properties and therefore pregnant and lactating women may not be inhibited from consuming it.*

Steps in Product Development

A number of sensory evaluation trials were carried out for the product development. The methods selected for sensory evaluation were ***affective tests.*** *For better understanding, the objectives, methods and the results of each trial are given consecutively step by step. Figure 7 summarizes the steps followed in the product development.*

Step I

Pretesting of sensory evaluation score cards (Lab Panel)

↓

Step II

Selection of type and amount of ingredients for biscuits (Lab Panel)

↓

Step III

Selection of that level of fenugreek seed powder at which acceptability among children would be minimal (Trials on preschool ICDS children)

↓

Step IV

Determination of acceptability of biscuits among pregnant and lactating women (Trials on ICDS P/L women)

↓

Step V

Commercial production of biscuits - Lab Panel

- *Shelf life determination* < *Sensory evaluation* / *Chemical analysis*
- *Nutrient composition - Chemical Parameters*

FIG 7: Flow of Product Development.

Step I

Obvjective : *To pretest (validate) the score cards for sensory evaluation.*

Method

Composition of Biscuits : *Two variations of methi biscuit were prepared in the laboratory. The amounts of ingredients were selected based on the standard composition used in the laboratory. These were :*

Ingredients	*Amount (g)*	
	Sample A	*Sample B*
Whole wheat flour	*40*	*45*
Jaggery	*40*	*40*
Ghee	*20*	*15*
Fenugreek seed powder	*1.5*	*1.5*

+ baking powder and water to make into a rolling consistency.

Sample : *The test was carried out on 10 untrained members (Students and Research Fellows of the Department of Foods and Nutrition). The biscuits were kept in two identical plates and codes were given. The time of testing was between 10 and 11 am. Water was provided for inbetween rinsing. The panel members were explained the objective of the test and the way to do it. The score card used is given in Figure 8.*

Results

1. *By and large the score was judged to be satisfactory.*
2. *The judges felt that the scores for individual attributes should be given.*
3. *It was difficult to mark sweetness, bitterness, crunchiness and chewiness on the given scale of very good to poor.*
4. *The score card lent itself to easy statistical computations.*

Based on these results the score card was modified as shown in Fig. 9.

Preparation of biscuits : Cream sugar, fat, butter and fenugreek powder together. Add sieved flour and knead. Roll uniformly & cut into pieces. Bake at [illegible]

Score Card

Name_____

Date_____Time_____

Instruction : *You are given two samples (A & B) of methi biscuit. Please taste each of them and mark your responses in the columns below :*

I. Composite Score Test

Attribute	***5***		***4***		***3***		***2***		***1***	
	Very Good		***Good***		***Fair***		***Poor***		***Bad***	
Sample	***A***	***B***	***A***	***B***	***A***	***B***	***A***	***B***	***A***	***B***
Appearance										
Colour										
Flavour										
Taste										
Bitterness										
Sweetness										
Texture										
Crunchiness										
Chewiness										
Amount of fat										
After taste										
Overall										

II Hedonic Test ***Sample A*** ***Sample B***

5 *Like it extremely*

4 *Like it moderately*

3 *Neither like nor dislike*

2 *Dislike (DL) moderately*

1 *Dislike extremely*

III *Preference :* *Sample*_____*Reasons for Preference*_____

IV. *Comments :*

Fig 8 : Score card used for sensory evaluation

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Name_____ Date_____

Product/s_____ Time_____

Instruction : *Please evaluate each biscuit sample for the quality factor listed below using the appropriate scale :*

Attribute	***Score***	***Attribute***	***Score***	***Overall Reaction***	***Score***
Appearance	*0 Poor*	*Bitterness or Sweetness*		*Dislike (DL) Extremely*	*1*
Colour	*1*				
Flavour	*2*				
Texture	*3*	*None*	*0*	*DL Very much*	*2*
Taste	*4*			*DL Moderately*	*3*
After-taste	*5*	*Slight*	*1*		
	6 Good		*2*	*DL Slightly*	*4*
	7	*Optimum*	*3*		
	8		*4*	*Like Slightly*	*5*
	9 Excellent			*Like Moderately*	*6*
				Like very much	*7*
				Like extremely	*8*

Your Scores

Attribute	***Sample***			
	A	***B***	***C***	***D***
Appearance				
Colour				
Flavour				
Texture				
Taste				
After-taste				
Bitterness				
Sweetness				
Overall reaction				

Preference : 1_____ 2_____ 3_____

Comments :

Fig. 9 : Modified Score-Card for Sensory Evaluation.

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Step II (a) Selection of ingredients

Objectives

1. *To select the ingredients for the biscuits.*

2. *To select the optimum amounts of the ingredients for the biscuits.*

Methods

A choice had to be made from the following ingredients :

1. *Whole wheat flour versus refined wheat flour*

2. *Soya flour versus bengal gram flour*

3. *With lecithin versus without lecithin*

4. *Sugar versus jaggery.*

Separate trials were carried out for each of the above. The composition of the biscuits is shown in Table **35.**

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Table 35 : Composition of the biscuits (100 g) with different variations of ingredients

I.	Ingredient	Sample A Whole wheat flour	Sample B Refined wheat flour
	Flour	40	40
	Jaggery	40	40
	Ghee	20	20
II.		With Soya flour	With Bengal gram flour
	Wheat flour	27	14
	Soya/Bengal gram flour	13	26
	Jaggery	40	40
	Ghee	20	20
III.		With lecithin	Without lecithin
	Flour	40	40
	Jaggery	40	40
	Ghee	20	20
IV.		With jaggery	With sugar
	Sugar/Jaggery	40	32*
	Flour	40	48
	Ghee	20	20

*32% sugar was added because sugar is sweeter than jaggery and less needs to be added.

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Biscuits were prepared using the same procedure as given before (page 100). Soya flour and lecithin were added at the creaming stage.

The panel for sensory evaluation was same as in Step I. The number of panelists ranged from 10 to 20 for various trials. The tests were carried out either between 10 am and 11 am or between 3 and 4.30 pm. The modified sensory evaluation score card (page 102) was used for all the trials.

Results

(i) ***Whole wheat flour versus wheat flour***

The mean scores obtained from the sensory evaluation are shown in Table 36. The average composite score was 33.4 (out of a maximum score of 54) for biscuits with whole wheat flour (WWF) and 30.4 for biscuits with refined wheat flour (RWF). The difference was not significant . The scores for individual attributes although higher for WWF were not significantly different from those of RWF. The sweetness of both the samples was judged as optimum. Sample WWF was preferred to sample RWF as seen from the scores on hedonic scale and ranking. However this could be because the judges were asked to give a preference and they might have felt it necessary to do so!

Conclusion

Since there was not much difference between the scores of biscuits with whole wheat flour or refined wheat flour, it was decided to use refined wheat flour because of technological considerations such as -

a. Uniformity in batches of the flour.
b. Increased shelf life of refined wheat flour compared to whole wheat flour.
c. Better baking property of refined wheat flour.

(The above information was obtained by personal communication with the Director of Windsor Foods Ltd., Baroda)

(ii) ***Soya flour versus bengal gram flour***

The levels for soya flour and bengal gram flour (13 and 26 g per cent respectively) were selected keeping in mind the total protein content of the biscuits since the purpose of adding soya/bengal gram flour was to raise the protein content. Thus by using 13 and 26 g of soya flour and bengal gram flour respectively, the protein content of the biscuits could be raised from approximately 5.5 g% to 11 g%. Soya flour could not be added at a level more than 13% because it would

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have been difficult to bake the biscuits with levels higher than 13% soya flour in the factory.

The total mean score for biscuits with soya flour was 31.0 as against 30.4 for biscuits with bengal gram flour (Table 37). Although the score for texture was somewhat higher for soya flour, the difference was not significant. There were no significant differences in the scores for other attributes. Out of 19 judges 12 preferred biscuits with soya flour and 7 preferred biscuits with bengal gram flour.

Conclusion

Since the biscuits with soya flour were preferred more than those with bengal gram flour, soya flour was the choice of ingredient for the product. Besides, the shelf life of biscuits with bengal gram flour has been reported to be less than that of soya flour biscuits (personal communication - Director, Windsor Foods Ltd., Baroda). Soya flour also lends a better texture to the biscuits (Smith, 1972).

Table 36 : Acceptance by the laboratory panel of biscuits with whole wheat flour (A) versus refined wheat flour (B).

Attribute	Maximum Score	Average Scores		d*	't' value
		Sample A	Sample B		
Total	54	33.4 ± 1.72	30.5 ± 1.59	2.9	1.23
Appearance	9	5.4 ± 0.44	5.0 ± 0.26	0.4	0.80
Colour	9	5.7 ± 0.44	4.8 ± 0.32	0.9	1.66
Flavour	9	5.0 ± 0.43	4.7 ± 0.39	0.3	0.51
Texture	9	5.2 ± 0.40	4.9 ± 0.37	0.3	0.55
Taste	9	6.0 ± 0.31	5.2 ± 0.48	0.8	1.40
After taste	9	5.9 ± 0.34	5.6 ± 0.33	0.3	0.63
Sweetness	5	3.1 ± 0.16	3.4 ± 0.16	0.3	1.36
Overall Reaction	8	5.7 ± 0.35	5.4 ± 0.27	0.3	0.68
Preference	-	10	5		

*difference (all the values were found to be non-significant).

n = 15

Table 37 : Acceptance by the laboratory panel of biscuits with soya flour versus bengal gram flour

Attribute	Maximum Score	Average Scores		d*	't' value
		with soya flour	with bengal gram flour		
Total score	54	31.0 ± 1.79	30.4 ± 1.26	0.6	0.27
Appearance	9	4.3 ± 0.47	4.5 ± 0.39	0.2	0.32
Colour	9	4.3 ± 0.44	4.6 ± 0.40	0.3	0.50
Flavour	9	4.7 ± 0.34	4.7 ± 0.33	Nil	-
Texture	9	6.0 ± 0.33	5.7 ± 0.33	0.3	0.65
Taste	9	5.8 ± 0.39	5.3 ± 0.28	0.5	1.04
After taste	9	5.7 ± 0.42	5.4 ± 0.30	0.3	0.58
Sweetness	5	2.8 ± 0.08	2.6 ± 0.13	0.2	1.33
Overall reaction	8	5.7 ± 0.20	5.6 ± 0.21	0.1	0.35
Preference	-	12	7		

*difference (all the values not significantly different).

(iii) Lecithin versus without lecithin

Lecithin was added at a level of 1%. Table 38 shows the scores of sensory evaluation of biscuits with lecithin (L) versus biscuits without lecithin (NL). The total score for L was 30.8 as against 29.5 for NL. There was no significant difference between the two scores. Although the scores for individual attributes were higher for L, there was no significant difference between L and NL. Out of 17 panelists, 9 preferred L; 5 preferred NL and 3 could not make a choice.*

Conclusion

Since lecithin facilitated rolling of biscuits dough and also the biscuits with lecithin were preferred by the panelists, it was decided to add it to the biscuits.

**Soya lecithin obtained from Windsor Foods Ltd.,(Baroda).*

Table 38 : Acceptance by the laboratory panel of biscuits with lecithin versus biscuits without lecithin

Attributes	*Maximum Score*	*Average Scores*		*d**	*'t' value*
		with lecithin	*without lecithin*		
Total Score	*54*	*30.8 ± 2.23*	*29.5 ± 2.07*	*1.3*	*0.42*
Appearance	*9*	*4.8 ± 0.51*	*4.5 ± 0.45*	*0.3*	*0.44*
Colour	*9*	*5.0 ± 0.47*	*4.4 ± 0.42*	*0.6*	*0.95*
Flavour	*9*	*4.8 ± 0.35*	*4.8 ± 0.33*	*Nil*	*0*
Texture	*9*	*5.6 ± 0.41*	*5.4 ± 0.47*	*0.2*	*0.32*
Taste	*9*	*5.3 ± 0.42*	*5.2 ± 0.41*	*0.1*	*0.17*
After taste	*9*	*5.1 ± 0.37*	*5.0 ± 0.41*	*0.1*	*0.18*
Sweetness	*5*	*3.0 ± 0.18*	*2.8 ± 0.17*	*0.2*	*0.83*
Overall reaction	*8*	*5.4 ± 0.23*	*5.5 ± 0.24*	*0.1*	*0.33*
Preference	-	*9*	*5*		

**difference (all the values found to be not significantly different).*

n = 17

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(iv) *Jaggery versus sugar*

As shown in Table 39 the composite score for biscuit with sugar (S) was 30.5 as against 33.5 for biscuits with jaggery (J). There was no significant difference in the scores of individual attributes of the two samples. There was no difference in the preference also as half of the judges preferred S and the rest preferred J.

Conclusion

Since there was no significant difference in the acceptability of biscuits with sugar or jaggery, sugar was chosen as the ingredient for the following reasons:

a. *Although jaggery is cheaper than sugar (Rs. 5 versus Rs. 6.30 per kg); the ultimate cost of both the type of biscuits would be approximately the same as the amount of sugar used was less (32 versus 40%) for the same sweetness.*

b. *Jaggery contained many impurities and purification would add to the cost.*

c. *The shelf life of jaggery biscuits would be much less because it absorbs moisture more readily than sugar.*

Thus based on the four trials described above, the choice of ingredients was:

1. *Refined wheat flour*
2. *Soya flour*
3. *Ghee (vegetable shortening)*
4. *Sugar*
5. *Lecithin.*

Table 39 : Acceptance by laboratory panel of biscuits with sugar versus biscuits with jaggery

Attribute	Maximum Score	Average Scores		d*	't' value
		Biscuits with sugar	Biscuits with jaggery		
Total	54	30.5 ± 2.53	33.5 ± 2.69	3.0	0.81
Appearance	9	4.4 ± 0.45	5.5 ± 0.50	1.1	0.29
Colour	9	4.2 ± 0.76	5.6 ± 0.54	1.4	1.50
Flavour	9	5.6 ± 0.54	5.4 ± 0.52	0.2	0.26
Texture	9	4.6 ± 0.46	5.9 ± 0.41	1.3	2.10
Taste	9	6.0 ± 0.57	5.9 ± 0.54	0.1	0.12
After taste	9	5.5 ± 0.51	4.9 ± 0.64	0.6	0.73
Sweetness	5	3.5 ± 0.23	2.7 ± 0.41	0.8	1.70
Overall reaction	8	6.0 ± 0.32	5.7 ± 0.32	0.3	0.66
Preference	-	6	6		

*difference (all the values not significantly different).

n = 12

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Step II (b)

Determination of the optimum amounts of the basic ingredients

The next step was to determine the optimum amounts of flour, sugar and ghee in the biscuits. The amount of soya flour was suggested by Windsor Foods Ltd and therefore that was not altered.

Method

From the literature available on the recipes of biscuits and also based on the standard composition of biscuits used in the laboratory the levels selected for different ingredients or factors were as follows :

Factor/ Ingredient	*Levels*			
	A	*B*	*C*	*D*
Flour	45	50	55	60
Sugar	25	30	35	
Shortening	15	20		

Using a complete factorial design (4 x 3 x 2), 24 combinations were possible from the above levels as shown in Table 40.

Table 40 : Possible combinations of amounts of different ingredients of the biscuits

S. No.	Combination	Flour	Sugar	Shortening
1.	AAA	45	25	15
2.	ABA	45	30	15
3.	ACA	45	35	15
4.	AAB	45	25	20
5.	ABB	45	30	20
6.	ACB*	45	35	20
7.	BAA	50	25	15
8.	BBA	50	30	15
9.	BCA*	50	35	15
10.	BAB	50	25	20
11.	BBB*	50	30	20
12.	BCB	50	35	20
13.	CAA	55	25	15
14.	CBA*	55	30	15
15.	CCA	55	35	15
16.	CAB*	55	25	20
17.	CBB	55	30	20
18.	CCB	55	35	20
19.	DAA*	60	25	15
20.	DBA	60	30	15
21.	DCA	60	35	15
22.	DAB	60	25	20
23.	DBB	60	30	20
24.	DCB	60	35	20

**The combinations selected for the trial because the amounts add up to 100.*

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Thus six combinations were selected for the final trial. The selection was not random. Those combinations were selected, wherein the amounts of the various ingredients added up to 100. These were as follows :

Factor	***Amount of Ingredients (g)***					
	A	**B**	**C**	**D**	**E**	**F**
Flour	*45*	*50*	*50*	*55*	*55*	*60*
Sugar	*35*	*35*	*30*	*30*	*25*	*25*
Shortening	*20*	*15*	*20*	*15*	*20*	*15*
Total	***100***	***100***	***100***	***100***	***100***	***100***

As seen from the above table, the levels of each factor are represented.

All the six samples were prepared in the laboratory on one day and were served together to the same laboratory panel as for the previous tests. The panel members were asked to rank the biscuits in order of preference besides the composite scoring for various attributes.

Results

The composite scores and scores for individual attributes are shown in Table 41. The scores on the composite score test ranged from 28.8 for Sample C to 37.8 for Sample E. The results of Analysis of Variance (ANOVA) showed that the differences between the scores were significant. A further test of Least Significant Difference (LSD) revealed that Sample E was significantly different from A and C but not B, D and F. All the scores on the individual attributes were higher for Sample E as compared to scores of other samples.

On the hedonic scale, the average scores ranged from 4.9 (Sample C) to 7.0 (Sample E). The differences were again significant between Sample E and C; and E and A, E being rated higher.

Out of the six samples, the most preferred sample was E followed by F, D, B, C and A - as revealed by the Kramer's Rank Sum Test (Table 42). Out of 12 judges 9 ranked Sample E as 1st. This test corroborated the results of the composite score test as Sample E was significantly better than Samples A and C but not D, F, and B.*

**Ref : Gatchalian, 1981.*

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Conclusion

Since the scores for Sample E were higher than other samples and it was the most preferred sample, it was decided to use the composition of Sample E for all subsequent trials. Thus the composition was :

Flour (including soya flour)	..	*55 g*
Sugar	.. .. ..	*25 g*
Shortening	.. .. ..	*20 g*
		100

+ lecithin + baking powder.

Table 41 : Sensory evaluation scores to determine the optimum amounts of ingredients in the biscuit

Attribute	Maximum Score	Average Scores Sample					
		A	B	C	D	E	F
Total Score	54	29.2 ± 2.04	31.4 ± 1.15	28.8 ± 1.96	34.4 ± 1.54	37.8 ± 1.76	34.5 ± 1.29
Appearance	9	4.5 ± 0.37	5.1 ± 0.31	4.8 ± 0.24	5.5 ± 0.27	6.4 ± 0.34	5.6 ± 0.26
Colour	9	4.8 ± 0.45	5.1 ± 0.40	4.6 ± 0.36	5.3 ± 0.32	6.0 ± 0.32	5.3 ± 0.34
Flavour	9	4.9 ± 0.32	5.0 ± 0.28	4.5 ± 0.42	5.5 ± 0.27	6.1 ± 0.38	5.5 ± 0.32
Texture	9	5.1 ± 0.40	5.5 ± 0.31	5.9 ± 0.40	6.0 ± 0.27	6.6 ± 0.40	5.8 ± 0.32
Taste	9	4.8 ± 0.36	5.1 ± 0.20	4.5 ± 0.45	5.6 ± 0.38	6.3 ± 0.39	5.9 ± 0.26
After taste	9	5.0 ± 0.42	5.4 ± 0.22	4.4 ± 0.47	5.7 ± 0.33	6.2 ± 0.29	6.0 ± 0.31
Sweetness	5	3.2 ± 0.28	3.3 ± 0.22	2.7 ± 0.29	2.9 ± 0.23	2.9 ± 0.14	2.8 ± 0.12
Overall reaction	8	5.0 ± 0.30	5.3 ± 0.17	4.9 ± 0.26	5.6 ± 0.17	7.0 ± 1.76	6.0 ± 0.20

F value for total scores 4.38 - significantly different at $P < 0.05$

LSD (Least Significant Difference) was 6.80 and by this test the samples E and A and E and C were significantly different ($P < 0.05$); rest not significantly different.

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Table 42 : Ranking by the laboratory panel of six samples of biscuits to determine the optimum amounts of ingredients (Kramer's Rank Sum Test)

Judge	Samples and Ranks					
	A	B	C	D	E	F
1.	3	4	2	6	1	5
2.	6	2	4	5	1	3
3.	6	5	3	2	1	4
4.	6	4	5	1	2	3
5.	5	3	6	4	1	2
6.	5	4	6	3	1	2
7.	2	3	6	4	1	5
8.	6	5	4	3	1	2
9.	4	3	6	2	5	1
10.	4	5	6	3	1	2
11.	6	2	5	1	3	4
12.	3	6	2	5	1	4
Total Rank	56*	46	55*	39	19*	37
Mean Rank	4.66	3.83	4.58	3.25	1.58	3.08

Tabulated Range of Rank Sum (for 6 samples and 12 judges) - 25 - 56

Calculated Range of Rank Sum - 19 - 56

*A and C significantly different from D ($P < .05$).

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Step III

Objectives

To determine that level of fenugreek seed powder in the biscuit at which it would have minimal acceptability among preschool children.

Method

The preliminary trials were carried out on the laboratory panel to get an idea of approximate levels of fenugreek powder to be used. After that the trials on children were carried out.

(1) ***Trial on the laboratory Panel***

For this trial, 3 levels of fenugreek seed powder were selected i.e. 0.5, 1.0 and 1.5 g per 100 g. The composition of the biscuits is shown below :

Ingredient	*Amounts (g)* Sample		
	A	*B*	*C*
Flour	54.5	54.0	53.5
Sugar	25.0	25.0	25.0
Shortening	20.0	20.0	20.0
Fenugreek powder	0.5	1.0	1.5
	100.0	***100.0***	***100.0***
+ lecithin and baking powder			

Fenugreek seeds were ground in a laboratory flour-mill and passed through a fine sieve. Fenugreek seed powder was weighed on a Mettler balance. The procedure for preparation of the biscuits was the same as described earlier. Fenugreek seed powder was added at the creaming stage.

The panel for sensory evaluation was same as described for Step I (page 100)

Results

The total scores for the three samples A (0.5%), B (1.0%) and C (1.5%) were 29.7 and 25.9 respectively (Table 43).

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The results of ANOVA and LSD for the total scores (Table 44) revealed that sample A was significantly different from C. However there was no significant difference between A and B and B and C. The scores on taste and after-taste also decreased as the level of methi seed powder in the biscuit was increased. On the hedonic scale the scores were 4.5 (between dislike slightly and like slightly); 3.7 (dislike moderately to dislike slightly) and 1.4 (dislike very much to dislike extremely) for A, B and C respectively. Thus samples B and C were not acceptable to the laboratory panel.

Table 43 : Acceptability of methi biscuits at three levels of methi seed powder by the laboratory panel (n = 13)

Sample	Total Score	Apearance	Colour	Flavour	Texture	Taste	After taste	Bitter ness	Sweet ness	Overall Reaction
A	29.7	5.1	5.1	4.7	5.8	4.7	3.1	2.7	1.9	4.5
(0.5% fenugreek)	±2.16	±0.43	± 0.40	± 0.39	±0.31	±0.46	±0.45	±0.34	±0.30	±0.33
B	26.7	5.3	5.1	4.3	5.7	3.7	2.3	3.6	1.9	3.7
(1.0%)	±2.03	±0.34	±0.40	±0.52	±0.32	±0.56	±0.45	±0.26	±0.28	±0.36
C	25.9	5.6	5.4	4.2	5.7	3.1	1.6	3.8	1.6	1.4
(1.5%)	±2.09	±0.31	±0.38	±0.56	±0.36	±0.59	±0.47	±0.29	±0.30	±0.39

F test (total scores) = 5.36 (P < .05)

LSD - 3.56

Also see Table 44.

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Table 44 : Results of F test (ANOVA)

Sources of Variation	*df*	*ss*	*ms*	*F*
Samples	*2*	*142.61*	*71.305*	*5.36**
Judges	*12*	*1838.92*	*153.24*	*11.52***
Error	*24*	*319.40*	*13.30*	
Total	***38***	***2300.93***		

* P < .05;

** P < .01

Results of LSD on above :

Sample	*Means*	*Differences*		*LSD*
A	29.76	A-B	3.0	
B	26.76	A-C	4.6*	3.56
C	25.15	B-C	1.6	

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(ii) ***Trials on children***

Since the laboratory panel rejected the biscuits with 1.5% fenugreek seed powder, the levels selected for preliminary trials on children were 0.5, 0.8, 1.2 g% (levels were selected arbitrarily). The biscuits were given for testing to children attending one Integrated Child Development Service (ICDS) Centre in Baroda city. On any one day only one level of fenugreek was tested. The number of children ranged from 27 to 33 on different days. Each child was given 5 biscuits (each weighing about 4 g). It was observed that at all the levels all the children could consume the given number of biscuits. Thus levels upto 1.2% were not sufficient to make the biscuits unacceptable to children.

Thus it was decided to raise the levels of fenugreek seed powder for subsequent trials which were conducted on a larger sample size.

Levels of fenugreek seed powder

For the final trials, fenugreek seed powder was added to the biscuits at a level of 2, 3, 4, 5 and 6%. Biscuits without fenugreek (Sweet Biscuit or SB) were also prepared to be used as control.

Preparation of Biscuits

Since the quantity of biscuits needed was substantial (about 2-3 kg/day), a local bakery was contacted for the biscuit preparation. This bakery also supplied sweet biscuits to the ICDS for supplementary feeding of children. The method of preparation was explained and was supervised by the investigator initially. Since the amount of fenugreek seed powder was important, it was weighed by the investigator and given to the bakery. The weight of the bakery biscuit was about 6-8 g per biscuit.

Sample

The trials were carried out on preschool children (3-6 yrs) attending three ICDS Centres in Baroda City. The enrolment of children in these centres was about 150. However the attendance was never found to be 100%. The number of children attending the centres ranged from 16 to 53 per centre on different days. Thus about 85 to 128 children were available for tests in the three centres.

Sensory Evaluation Test : *The tests were conducted between 12 noon and 2 pm which was the time when the food supplement was usually given to the children. Each child was initially given 2 biscuits (weight of one biscuit 6-8 g). If the child consumed 2 biscuits and asked for more he/she was given more biscuits (2 at a*

time). A record of the following was maintained :

1. *Number of children asking for more than 2 biscuits.*

2. *Number of biscuits consumed by each child.*

Results :

The criteria for acceptability of biscuits by children were :

1. *Number of children asking for more than 2 biscuits. (It was assumed that if the child wanted more biscuits, it must be acceptable).*

9 *The number of biscuits consumed by each child : The consumption was considered as low when it was less than or equal to 2 biscuits; average if it was 3-4 biscuits; high if it was 5 to 8 and very high if it was above 9.*

The results are discussed according to the above criteria.

Table 45 and Fig. 11 show the number of children asking for more than 2 biscuits at different levels of fenugreek seed powder. When the children were given biscuits without fenugreek (sweet biscuits) the acceptability was almost universal. About 96% children asked for more than 2 biscuits (about 12-16 g). When fenugreek seed powder was added at a level of 2%, 59% children asked for more than 2 biscuits. There was a sharp decline in the number of children desiring more biscuits when the level of fenugreek seed powder was increased from 2 to 3%. There was no significant difference in this number when the level was further raised to 4, 5 or 6%. At 3, 4, 5 or 6% level of fenugreek, 26, 23, 26 and 31% children demanded more than two biscuits respectively. There was no significant difference in these numbers.

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Fig. 10 : *Preschool ICDS children. The major sharers of the maternal food supplement.*

Table 45 : Number of children asking for more than 2 biscuits at different levels of fenugreek seed powder

Level of fenugreek (%) seed powder	Number of children asking for more biscuits							
	ICDS Centre						Total	
	A		B		C			
	n	%	n	%	n	%	n	%
0	23 (25)*	92	52 (53)	98	48 (50)	96	123 (128)	96
2	23 (30)	77	21 (53)	40	28 (40)	70	72 (123)	59
3	20 (37)	54	2 (34)	6	6 (37)	16	28 (108)	26
4	15 (25)	60	4 (44)	9	8 (50)	16	27 (119)	23
5	18 (33)	55	4 (52)	8	-	-	22 (85)	26
6	23 (33)	70	3 (42)	7	11 (45)	24	37 (120)	31

*Numbers in parentheses indicate the number of children on which the trial was conducted.

** Also refer to Fig 11.

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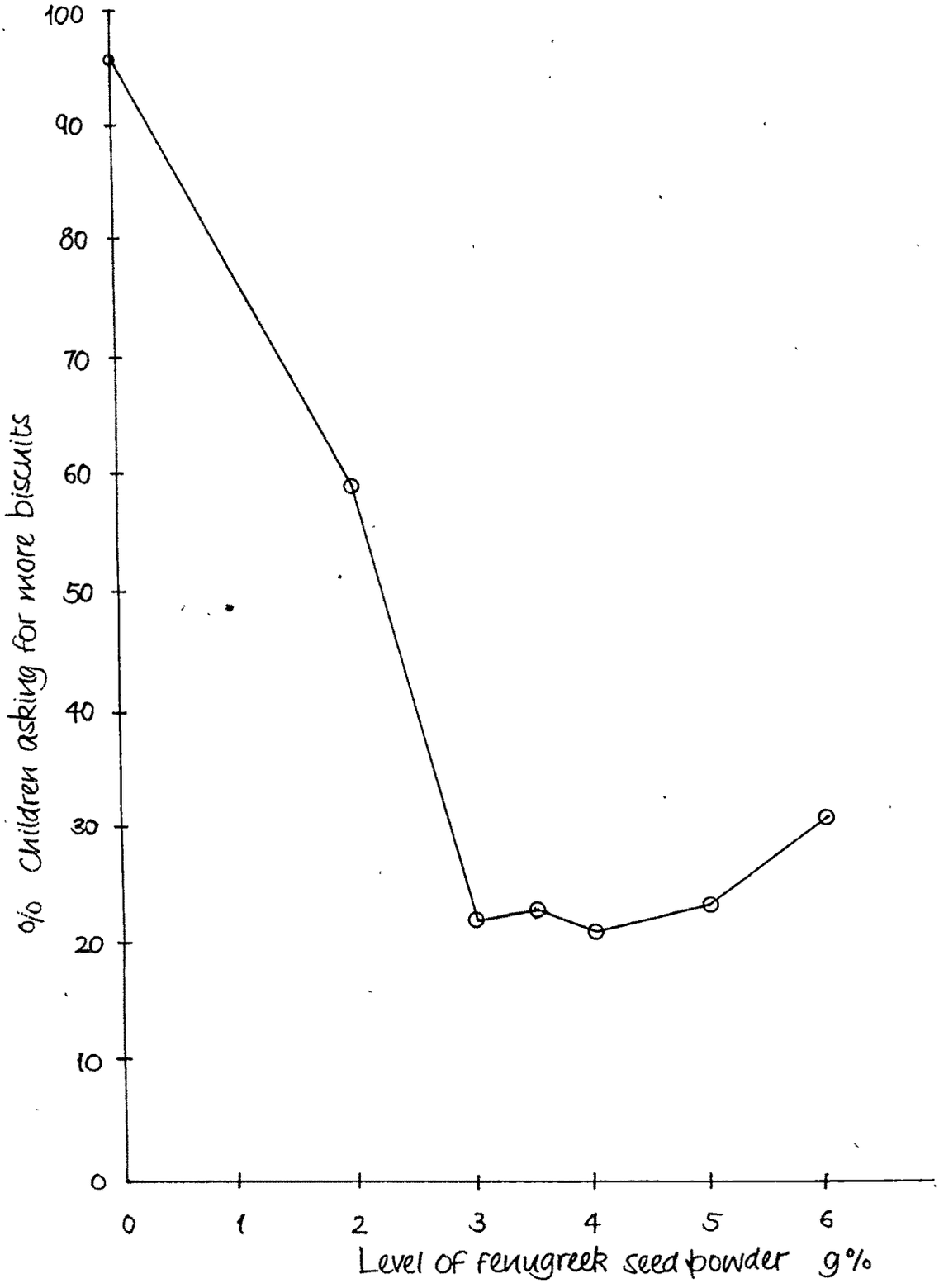

Fig. 11 Acceptability of biscuits at different levels of fenugreek seed powder among children

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The results of the consumption of biscuits also showed similar trends (Table 46 and Fig. 12). When the biscuits contained no fenugreek seed powder, about 84% children consumed more than 5 biscuits each (considered as high). At 2% fenugreek level, only 35% children could consume more than 5 biscuits and at levels of 3, 4, 5 and 6% fenugreek, 4 to 11% children could consume more than 5 biscuits. At these levels none of the children could consume more than 8 biscuits (very high). There was no significant difference in the consumption at 3, 4, 5 or 6% level of fenugreek.

Thus 3% could be considered the level at which the acceptability of biscuits was minimal among the ICDS children, since increasing the level from 3 to 6% did not result in any significant drop in the acceptability. Some children could tolerate the bitter taste irrespective of the intensity of bitterness.

Based on the results of these trials, 3% was selected as the cut-off point for fenugreek seed powder which would make the biscuits least acceptable to children.

Table 46 : Number of biscuits consumed by children at different levels of fenugreek seed powder

Number of biscuits consumed	Number of children											
	Level of fenugreek seed powder (%)											
	0 (No fenugreek)		2		3		4		5		6	
	n (128)*	%	n (125)	%	n (123)	%	n (119)	%	n (85)	%	n (120)	%
0	0	0	18	14	57	46	64	54	32	38	61	50
1 - 2	3	2	29	23	34	28	32	27	32	38	21	17
3 - 4	18	14	35	28	23	19	18	15	15	18	27	22
5 - 8	101	79	36	29	9	7	5	4	6	7	11	9
9 - 12	6	5	7	6	0	0	0	0	0	0	0	0

* Numbers in parentheses indicate number of children on whom the trial was conducted.

** Also refer to Fig. 12.

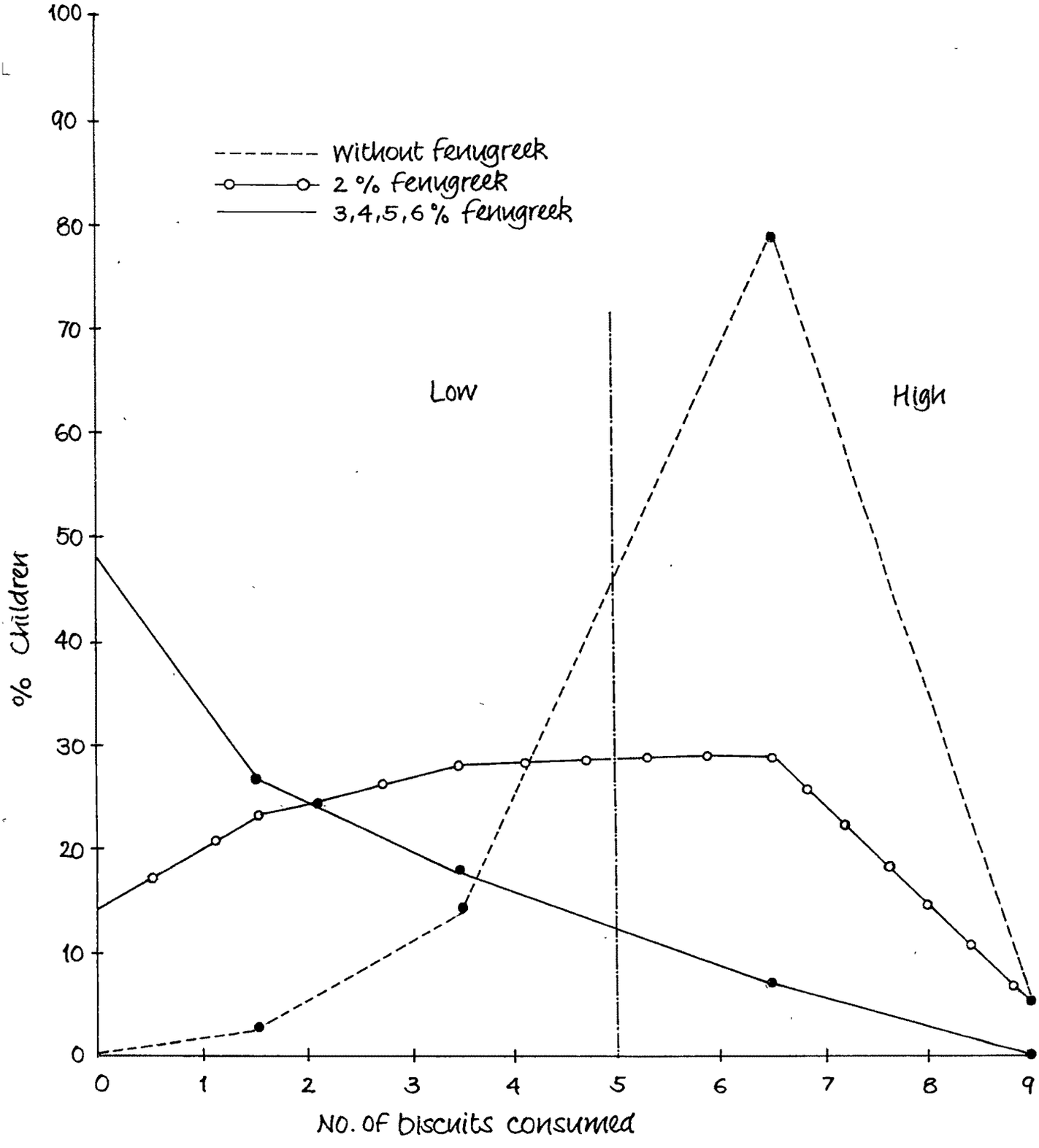

Fig.12: Consumption of biscuits with different levels of fenugreek seed powder by preschool children

Step IV

Trials on pregnant and lactating women

Objectives

To determine the acceptability of biscuits with 3% fenugreek seed powder among pregnant and lactating women.

Methods

Sample : *The sample for this trial consisted of 61 pregnant and lactating women (pregnant women in II and III trimesters and lactating women upto 6 months of lactation) beneficiaries of three ICDS Centres of Baroda City (same centres as selected for trials on children). No background details were obtained since acceptability was the main aim. However since methipak is a very popular food among the Gujarati ethnic group, information was collected on the ethnic group of the subjects. Out of 61 women, 32 (53%) were Gujaratis; 25 (41%) were Muslims and 4 (6%) were Maharashtrians.*

Although the initial enrolment was 61, more subjects voluntarily came forward for enrolment as the trial proceeded and by the end of the trial 36 more women enrolled.

Product selected for the trial

Based on the acceptability trials on children, a 3% level of fenugreek seed powder was selected, since at 2% level the biscuits were found to be acceptable by more than 50% children. The biscuits were prepared in bulk by a local bakery. They were then packed in polythene bags. One packet contained 200 g (about 25 pieces). This was the take-home ration for 2 days (at 100 g/day per subject).

Distribution

Pregnant and lactating women enrolled in the study were asked to come to the centre every alternate day. Each subject was given one packet (200 g) on the day of visit to the centre. A record was maintained for the number of women coming to collect the biscuits. The trial period was 15 days.

Results

It was assumed that women who came to collect the biscuits regularly accepted them. It was observed that some women who did not like the taste of the biscuits still came to collect them because they considered them good for health and inspite of the bitter taste were willing to eat them. Certain women rejected the biscuits completely and did not come to collect them regularly. Out of the 61 subjects who enrolled initially 69% subjects collected the biscuits regularly; 18% dropped out because

they did not like the biscuits and 13% dropped out because of other reasons such as falling sick or out of town or community. An interesting observation was that out of 15 women who disliked the biscuits and did not come to collect regularly, 10 were Muslims and 5 were Gujaratis. Thus it is possible that ethnic group might affect the acceptability. It is to be noted that the trial period for the subjects who did not erol on the 1st day was not 15 days. However, the women who rejected the biscuits did so in the first 3-4 days itself and therefore continued collection even for 3-4 times could be considered as an indicator of acceptability.

Not considering the drop outs (and assuming that the drop outs would more or less represent the original sample), it can be stated that 82% women accepted the biscuits and the rest rejected them.

Conclusion

Although there were no definitive data to establish that the sharing of biscuits with 3% methi was minimal, this level was selected, based on the results of two separate trials (one on the 'below six' child population; and one on the pregnant and lactating women). Since most of the preschool children who are reported to be the major sharers of the maternal supplement (NIN, 1981), stopped accepting the biscuits at 3% level of methi, and majority of the pregnant and lactating subjects continued to collect the biscuits with same bitterness, it was inferred that a major portion of the biscuits would be consumed by the mothers themselves. Collection of data on consumption of methi biscuits by family members such as the school children and the men was not considered necessary because these two groups are not generally at home during the day-time and it has been established by NIN (1981) in the India Population Project and Project Poshak (Gopaldas etal 1975) that sharing of the maternal supplement by these groups was negligible.

Step V

Commercial Production of Biscuits

Objectives

1. *To determine if the bitterness of the biscuits prepared by the investigator was equivalent to that in biscuits produced commercially.*
2. *To determine the shelf life of commercially produced biscuits.*
3. *To determine the nutrient composition of the commercially produced biscuits.*

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To fulfill the above objectives, the results of this phase are presented under three heads :

(i) Commercial production of biscuits

(ii) Shelf life analysis

(iii) Nutrient composition analysis.

(i) ***Commercial production***

To determine if the bitterness of the biscuits prepared in the laboratory by the investigator was equivalent to that of biscuits produced by Windsor Foods Ltd., the recipe with 3% fenugreek seed powder was given to Windsor Foods Ltd. and they were requested to prepare a sample of the biscuits. The bitterness of the two biscuit samples (prepared by the investigator and Windsor Foods Ltd.) was compared by a laboratory panel of judges. Out of 10 judges, 5 found the biscuits prepared by the investigator more bitter than Windsor biscuits, 2 judges could not differenciate between the two and 3 found Windsor biscuits more bitter.

A trial was also conducted on the pregnant and lactating women. The bitterness of biscuits prepared by the investigator and Windsor Foods Ltd. was compared. Out of 29 women 21 judged the Windsor biscuits as less bitter; 6 could not differenciate between the two and only 1 found Windsor biscuits more bitter than those prepared by the investigator.

Thus, based on both these trials, it was concluded that the Windsor biscuits were less bitter than those prepared by the investigator. One possible reason for this could be that the fenugreek seed powder was accurately weighed on the Mettler balance by the investigator whereas Windsor Foods Ltd. used the ordinary balance for weighment.

Thus the final product was standardized with 4% fenugreek seed powder. The final composition of the biscuits was as follows :

Ingredient	***Amount / 100 g***
Refined wheat flour . .	*38.0*
Soya flour . .	*13.0*
Sugar . .	*25.0*
Shortening . .	*20.0*
Fenugreek seed powder . .	*4.0*
+ lecithin and baking powder*	***100.0***

**Lecithin was added at a level of 1% of the fat content (in this case 0.5 g%); Baking powder was also added at a level of 0.5 g%)*

The specifications for the ingredients used for biscuits produced were as follows (Personal communication, Director Windsor foods Ltd, Baroda) 133

Refined Wheat Flour

% Gluten	--	9.5	(Max)
% Moisture	--	12.0	(Max)
% Ash	--	0.80	(Max)
% Alcoholic Acidity	--	0.09	(Max)
% Acid Insoluble Ash	--	0.04	(Max)

Soya Flour

% Protein	--	40.0	(Max)
% EF Acidity (Extracted Fat)	--	0.7	(Max)
% Fat	--	7.0	(Max)
% Moisture	--	6.0	(Max)
% Ash	--	5.0	(Max)
% Acid Insoluble Ash	--	0.05	(Max)

Shortening

A hydrogenated blend of cotton seed, rape seed and mustard oils.

Packaging

The biscuits were produced in bulk by Windsor Foods Ltd. Baroda and were packed in rolls of 100 g each. Each roll contained about 16 biscuits (weight of one biscuit - about 6 g). The first packing was done in ***waxed post paper*** *and the second packing was done in bags of* ***polypropylene film of 150 gauge.*** *(see picture on page 134). The rolls were bulk packed in cardboard cartons of 6 kg each (60 pkts to one carton). These biscuits were also used for the product testing (chapter 5) and shelf life determination. For comparison, sweet biscuits (without fenugreek) were also produced in bulk.*

Cost of Production

The breakdown of the cost of the biscuits was as follows :

	Rs. / Kg.
Ingredients	6.00
Cost of Production	1.00
Packaging	2.40
Overheads	2.50
Taxes (Excise and Sales Tax) 20% ..	2.40
Total ..	**14.30**

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Fig. 13 : *Hundred g packets of biscuits in wax paper (in the centre) and polythylene bags.*

Fig. 14 : *Bulk packaging of biscuits in cardboard boxes (each box carries 60 packets)*

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The cost of one day's ration for one beneficiary would be about Re. 1.45 as against the present budget allocation of Re. 1.05 per day per beneficiary (Khanna and Ohri 1986). However, the cost could be brought down, if low-cost packaging material is used and also if the Government exempts the biscuits from excise duty and sales tax.

Shelf life determination of the biscuits prepared by Windsor Foods Ltd.

Definitions of the terms

(i) ***Shelf life***

The period from the time of its preparation or manufacture during which a food remains suitable for human consumption is limited and is commonly known as the ***shelf life of the food*** *(Richardson 1977). Shelf life is determined by the rate of quality deterioration of a product during storage under normal conditions. When the quality deterioration has reached a stage at which the product ceases to be acceptable as reasonably fresh, its shelf life terminates. This deterioration may in general terms be ascribed to moisture change; staling, flavour deterioration and microbial spoilage (Herschdoerfer, 1968).*

The shelf life of a food is not a fixed period but is dependent upon the conditions under which the foods is stored. The most important of these conditions is temperature, but other conditions such as package attributes, atmospheric humidity and exposure to light may all be important for specific foods (Richardson, 1977).

The shelf life of biscuits may be limited by gross changes in moisture content due to the permeability to water vapour of the packaging container, which causes softening of the biscuits and also by the onset of oxidative rancidity in the fat, causing marked flavour deterioation (Axford e t al 1967).

Moisture content

The water content of most foods products is a function of the temperature and humidity of the surrounding atmosphere. At any given relative humidity and temperature, the moisture content of a material will rise or fall until conditions of equilibrium are reached. If the temperature is kept constant the factor controlling equilibrium conditions will depend on the ratio of material volume to sorrounding atmosphere volume. For example, if biscuits are left exposed to the atmosphere or placed in a cabinet in which the relative humidity can be maintained at a constant value, then the biscuits will absorb moisture until they are in equilibrium with the relative humidity. On the other hand, if a tin is filled with biscuits, closed and sealed, the biscuits will absorb some moisture from the small air space, thus lowering its

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relative humidity. The amount of moisture available in this way to the biscuits, however is very small and in general its effect on their moisture content will be barely measurable so that equilibrium conditions are controlled by the biscuits (Ottaway, 1956).

***Rancidity** : Fats undergo changes during storage which result in the production of an unpleasant taste and odour which is commonly referred to as rancidity. Rancidity is brought about by the action of air (oxidative rancidity) or by microorganisms(ketonic rancidity). Oxidative rancidity is accelerated by exposure to heat and light, by moisture and by the presence of traces of certain metals (e.g. copper, nickel, iron). Oxygen is taken up by the fat with the formation of compounds which react as peroxides. In general, the greater the degree of unsaturation, the greater is the liability of the fat to oxidative rancidity. When the concentration of peroxides reaches a certain level, complex chemical changes occur and volatile products are formed which are mainly responsible for the rancid taste and odour.*

With most oils and fats, the free acidity increases during storage, but with refined oils particularly, the free fat acidity figure is not necessarily related to the extent to which rancidity has progressed. On the other hand although the peroxides are possibly but not directly responsible for the taste and odour of rancid fats, the concentration of them as represented by the peroxide value is often useful for assessing the extent to which spoilage has advanced.

***Peroxide Value (PV)** : The peroxide value is a measure of the peroxide contained in the oil. During storage, formation is slow at first during an induction period which may vary from a few weeks to several months according to the particular oil or fat, the temperature etc.*

Fresh oils usually have PV well below 5 ml N/500 thiosulfate per g. A rancid taste is often just noticeablewhen the PV is between 10 and 20 (Pearson 1962).*

***Acid value or Free Fatty Acidity (FFA)** : The acid value of an oil or fat is defined as the number of mg of KOH required to neutralize the free acid in 1 g of sample. The acid value is a measure of the extent to which the glycerides in the oil have been decomposed by the lipase action. The decomposition is accelerated by heat and light. As rancidity is generally accomplished by free fatty acid formation, the determination is often used as a general indication of the condition and edibility of fats and oils. The FFA is usually calculated as oleic acid (1 ml N/10 = 0.028 g oleic acid). With most oils, rancidity is noticeable to the palate when the acidity as oleic acid is about 0.8 to 1.5% (Pearson 1962).*

**PV is also expressed as milliequivalents of peroxide oxygen per kg of sample and is obtained by multiplying the value of N/500 thiosulfate by 2.*

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Methods

Sample : *For the shelf life studies of biscuits, the biscuits prepared by Windsor Foods Ltd. were used. As already mentioned the biscuits (both methi biscuits and sweet biscuits) were packed in a wax paper and then a polythene bag (150 gauge). The biscuits were bulk packaged in 6 kg cartons (60 packets of 100 g each in one carton).*

Storage conditions

The shelf life was determined under two conditions of storage :

1. *Ambient temperature and relative humidity.*
2. *Accelerated temperature and relative humidity.*

(1) ***Ambient temperature and relative humidity***

For this, the cartons of biscuits were kept at room temperature for more than 3 months. The shelf life testing was carried out from June to September. The range and averages of minimum and maximum temperatures and relative humidity in these months are shown in Table 47. Biscuit samples were drawn at regular intervals (15-20 days) and were evaluated for spoilage (as described later).

(2) ***Accelerated temperature and relative humidity***

Since shelf life studies under atmospheric temperature and relative humidity take a considerably long time, a method has been developed wherein the temperature and relative humidity can be manipulated (generally increased from the ambient). The deterioration under these accelerated conditions of temperature and RH is much faster from that at room temperature and RH. If the shelf life is once tested under both the conditions, for subsequent testing, it can be predicted from the accelerated testing and therefore there is no need to do it at ordinary conditions of temperature and RH. The procedure for this has been standardized by Windsor Foods Ltd. (Baroda) and is as follows :

1. *Maintain the humidity oven at 45°C and 75% humidity.*
2. *Determine the percentage moisture content and the free fat acidity of the extracted fat.*
3. *Place the samples under test in their final packages inside this oven.*
4. *Remove the samples from the oven at periodic intervals (24 h; 48 h; 72 h; 96 h and so on) and analyse for percentage moisture and acidity of the extracted fat consecutively for a period of 8 days (192 h).*

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Table 47: Atmospheric temperature & relative humidity from June to Nov. in Baroda city

Month of Study	Temperature				Relative Humidity			
	Minimum		Maximum		Minimum		Maximum	
	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
June	27.2 to 29.2	28.4	34.9 -40.4	37.4	31-51	41	64-79	71.5
July	24.9 to 28.0	26.0	27.9 -37.2	32.6	73-98	85.5	39-85	62
Aug	24.3 to 26.1	25.2	26.9 -34.3	32.2	75-99	87	44-89	66.5
Sept	24.0 to 27.6	25.3	31.9 -40.2	35.5	66-90	78	32-67	49.5
Oct	17.6 to 26.8	22.5	24.9 -41.4	35.5	67-100	83.5	22-53	87.5
Nov.	15.0 to 19.2	17.2	31.7 -36.6	33.8	70-85	77.5	24-38	31

Source : Meterological observatory

M.S. University, Baroda

5. *If the biscuits are unaltered in the chemical constituents for the entire period of 192 h, then it can be concluded that under normal conditions of storage (30°C and 50% RH) the biscuits in its package can be kept safe for a period of 80 (2-1/2 m) from the date of packaging.*

Parameters for shelf life testing

1. *Moisture content*
2. *Free fatty acidity*
3. *Peroxide value*
4. *Sensory evaluation by lab panel.*

The details of each method are given in Appendix II.

Results

1. ***Shelf-life at ambient temperature and relative humidity***

Table 48 shows the results of shelf life testing at ambient temperature and relative humidity. The testing was conducted every month. The moisture content, peroxide value and free fatty acid values were below the level at which deterioration of the biscuits takes place. The biscuits were found acceptable by the laboratory panel upto 4 months. The testing was terminated at 4 months.

2. ***Shelf life at accelerated temperture and relative humidity***

As shown in Tables 49, 50 the biscuits were stable for a period of 8 days under the accelerated conditions of temperature (45°C) and humidity (90%). The moisture content on the 8th day was 4.7% for sweet biscuits and 4.66% for fenugreek biscuits. According to IS specifications (IS 1981), the biscuits can be acceptable if the moisture content does not exceed 6%. The peroxide value was 0 till the end of the experiment and free fatty acid was less than 1% (IS limit for deterioration). The biscuits were acceptable (as judged by a laboratory panel) both for texture and flavour.

According to Windsor Foods Ltd, if the biscuits are stable for a period of 8 days or 192 h under accelerated conditions of temperature and humidity, their shelf life can be considered as 80 days if kept at room temperature and humidity.

In conclusion, the shelf life of biscuits under accelerated testing was found to be more than 80 days. It was found to be more than 4 months at room temperature and humidity.

Table 48 : Results of shelf-life testing under ambient temperature and relative humidity

Intervals of Testing	Moisture %		Peroxide Value*		Free fatty acid**		Sensory evaluation	
	Sweet Biscuit	Methi Biscuit	Sweet Biscuit	Methi Biscuit	Sweet Biscuit	Methi Biscuit	Sweet Biscuit	Methi Biscuit
0 day	3.31	3.0	0	0-	-	0.63	Acceptable	
1st m (30 days)	3.37	3.59	0	0	0.56	0.60	Acceptable	
2nd m (60 days)	3.5	3.9	4.2	2.3	0.70	0.77	Acceptable	
3rd m (90 days)	3.7	3.2	2.4	3.3	0.81	0.98	Acceptable	
4th m (120 days)	4.61	5.05	2.59	3.3	0.72	0.79	Acceptable	

*meq / kg sample

**as oleic acid percent by mass.

Table 49 : Results of accelerated shelf life testing of biscuits (Moisture, Peroxide Value, Free Fatty Acid Value, Sensory Evaluation Scores)

Day of trial	Moisture*		Peroxide value		Free fatty acid*		Sensory evaluation**	
	Sweet Biscuits	Methi Biscuits	Sweet Biscuits	Methi Biscuits	Sweet Biscuits	Methi Biscuits	Sweet Biscuits	Methi Biscuits
0	3.37	3.59	0	0	0.56	0.60	Acceptable	
1	3.70	3.89	0	0	0.51	0.53	Acceptable	
2	3.69	4.23	0	0	0.49	0.56	Acceptable	
3	3.72	3.97	0	0	0.54	0.56	Acceptable	
4	4.14	-	0	0	0.63	0.56	Acceptable	
5	4.22	4.16	0	0	-	0.69	Acceptable	
6	4.47	4.43	0	0	0.56	0.61	Acceptable	
7	4.73	4.66	0	0	0.53	0.75	Acceptable	

*IS standard for Moisture - 6.0%

and for Acidity of extracted fat (as oleic acid %) - 1.0%

** For details of sensory evaluation scores see Table 50.

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Table 50 : Mean scores of sensory evaluation scores for shelf life testing of sweet and methi biscuits

Day of testing	Sweet Biscuit		Methi Biscuit	
	Flavour*	Texture**	Flavour	Texture
0	3.88 (1)	3.88 (1)	4.0 (1)	4.0 (1)
1	4.0 (1)	4.11 (1)	3.5 (0.88)	3.33(0.88)
2	3.9 (1)	3.8 (1)	3.7 (1)	3.4 (1)
3	3.84 (1)	3.46 (1)	3.84 (1)	2.76(1)
4	3.90 (1)	3.63 (1)	3.45 (1)	3.0 (1)
5	3.90 (1)	3.40 (1)	3.6 (0.9)	2.7 (1)
6	4.0 (1)	3.3 (1)	3.7 (1)	3.0 (1)
7	4.1 (1)	3.1 (1)	3.87 (1)	3.12(1)
8	3.85 (1)	3.14 (1)	3.85 (1)	3.0 (1)

* *A score of 4 for flavour indicates that rancidity is undetectale. A score of 3 indicates it is detectable. A score of 1 (in parenthesis) indicates that biscuits are acceptable for both flavour and texture.*

** *A score of 4 for texture indicates that texture is very good, 3 indicates good texture and 2 fair.*
(Refer details of Score-Card in Appendix

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Nutrient composition of the biscuits

The biscuits were analysed chemically for the following nutrients. Calorie content was obtained from the food composition tables (ICMR 1981) :

1. *Protein content (Ranganna 1977).*
2. *Fat content (Soxhlet's method).*
3. *Crude fibre (NIN 1983).*
4. *Ash content (NIN 1983).*
5. *Iron (Oser 1976).*
6. *Bioavailability of iron (Narsinga Rao and Prabhavati 1978).*
7. *Calcium (Pearson 1962, Oser 1976).*
8. *Thiamine (AACC 1983).*
9. *Riboflavin (AACC 1983).*
10. *Lysine bioavailability (Carpenter, 1960).*

The details of each of the above methods are given in Appendix II.

Table 51 shows the nutrient composition per 100 g of the biscuit. As seen, they provided substantial amounts of calories and protein. The content of minerals (iron and calcium) and vitamins (thiamin and riboflavin) was not too high. It was expected that since fenugreek seeds are a good source of lysine, the bioavailability of lysine would be higher in methi biscuits but it was not found to be so experimentally. It is possible that there was loss of lysine during baking. Thiamine and riboflavin also being heat labile could have been destroyed by the temperatures of baking. Although the iron content was low, the bioavailability (ionisable iron) was found to be very high, i.e., about 47% for both sweet and methi biscuits. Such high values are rare for vegetable sources. However, it has been shown that the bioavailability of iron increases on baking. In a study, Prabhavathi and Narasinga Rao (1979), reported that the bioavailability of iron from refined wheat flour was 8.2% whereas, it was 21% in baked bread. The total iron content was 1.8 and 2.2 mg% for refined wheat flour and baked bread respectively. In another study in this Department Goyle (Personal communication) observed similar results. The ionizable iron of raw wheat and bengal gram mix was 11% and that in the biscuits baked from same mix was 21%. Thus, there is a need to establish the effect of processing like baking on the bioavailability of iron.

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The iron and calcium content were not considerable. However biscuits can always be enriched with these nutrients, if required.

Table 51 : Nutrient composition of sweet and methi biscuits per 100 g

Nutrient	Sweet Biscuits	Methi Biscuits
Calories (Approx)	475	475
Protein (g%)	10.95	11.81
Fat (g)	25.21	25.17
Crude fibre (g)	negligible	negligible
Ash (g)	0.066	0.075
Moisture (%)	5.05	4.61
Iron (mg)	2.0	2.8
Calcium (mg)	44.2	72.5
Thiamin (mg)	0.059	0.058
Riboflavin (mg)	0.08	0.11
Lysine Bioavailability (g/100 g protein)	1.395	1.23
Iron Bioavailability		
Soluble Iron %	84.7	82.2
Ionisable iron %	46.6	47.0