A School Distributed Cookie is an Excellent Source of Vitamin A

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The nutritionally improved cookie

- Weight: 28 g
- Energy: 140 Kcal
- High quality protein: 2g (> 80% milk value)
- Wheat flour (25%)
- Maisoy flour (25%) Dehulled corn flour and defatted soybean flour (70:30)
- Lard, sugar, salt and flavoring

COOKIE

(Snack)

↓

1.6 million children

↓ ↓

Pre-elementary public school

Elementary public school

Guatemala
Micronutrient deficiencies

↓

Food Fortification programs

Fortified sugar with vitamin A

Salt with iodine

Wheat flour with iron

Nutritious cookie

↓

Vitamin A (75% RDA)
B complex Vitamins
Iron

OBJECTIVE

To determine the stability of retinol during the baking process as well as through the shell-life (45 days) of the cookie in order to assess its relevance as a source of Vitamin A

Fortified Maisoy flour Vitamin A (250-CWS)
Niacin, Thiamine, Riboflavin, Iron

Batch of cookies

Analysis of Maisoy flour

Analysis of cookies just baked

STORAGE
25°C

70 - 80%
Relative humidity

15 days

30 days

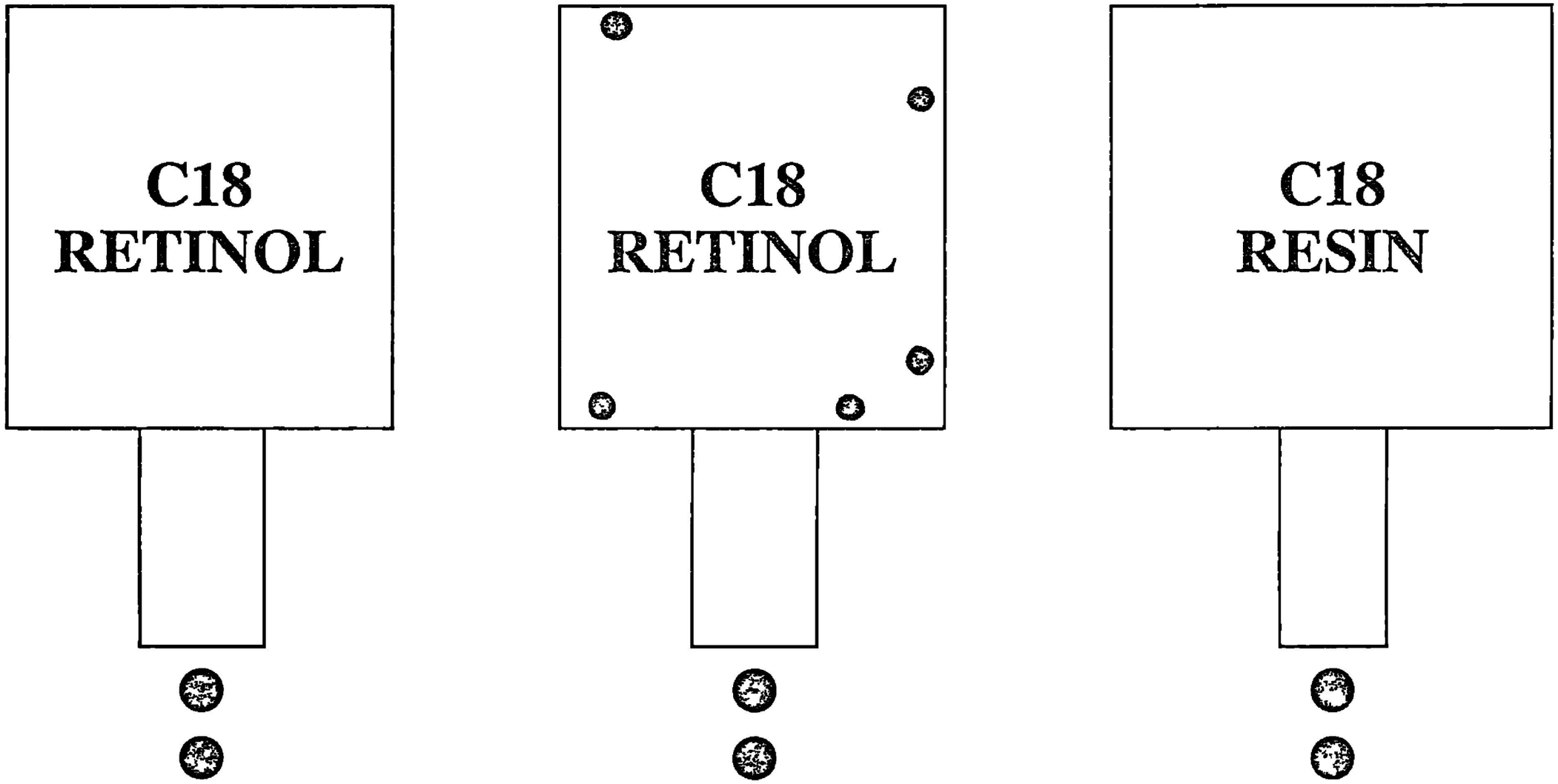
45 days

ACETONITRILE/WATER

SAMPLE

SOLUTION

ISOPROPYL ALCOHOL



WASTE

HIDROPHILIC SUBSTANCES

RETINOL

Initial retinol content of the fortified ingredients

Retinol content	(μg/g)	Amount used/batch
Maisoy Flour	95	0.57 kg
Sugar	2	0.68 kg
Cookie	23	2.20 kg
Cookies/batch	80	

Loss During the Baking Process

Total retinol content	(μg/batch)
Before baking	54893
After baking	49696
Loss (μg)	5197
Retained percentage	90.5%
Loss percentage	9.5%

TOTAL COST OF COOKIE FORTIFICATION

- Vitamin A: US$95 per million cookies
  US$0.015 per child in a school year (150 days)

- All micronutrients: US$0.12 per child/year
  One cookie US$0.0008

CONCLUSION

- The nutritionally-improved cookie is an excellent vehicle to provide Vitamin A with the only requirement that the cookie be consumed in a regular and continuos base.

SLIDE 1

The title of my presentation is a school-distributed cookie is an excellent source of vitamin A. This work was realized by Omar Dary, Leonardo de Leon and myself in a collaboration of the Institute of Nutrition of Central America and Panama and Universidad del Valle de Guatemala.

SLIDE 2

This cookie is called the nutritionally improved cookie and it was formulated by the Institute of Nutrition of Central America and Panama to provide to all children that consume it a good source of energy and a high quality protein. It weights 28 g, provides 140 kcal and 2 g of a high quality protein that is more that 80% of the milk value. It is made of 25% wheat flour, 25% a special flour called Maisoy- that is a mixture of dehulled corn flour and defatted soybean flour in proportion of 70:30-, lard, sugar, salt and flavoring.

SLIDE 3

This cookie is consumed as a snack and is delivered daily to about 1.6 million children attending pre-elementary and elementary public schools.

SLIDE 4

Due to the prevalence of micronutrient deficiencies in Guatemala, several food fortification programs are being carried out to eradicate and prevent it. The most important food fortification interventions are the fortified sugar with vitamin A, salt with iodine and wheat flour with iron. However, there are areas in the country where people consume a brown sugar loaf instead of fortified sugar and in the case of iron, bread is not as accesible and economical as tortillas, that is a food of popular consumption. Then the cookie was considered as a vehicle to carry micronutrients including vitamin A, B complex vitamins (niacin, thiamine and riboflavin) and iron to reach at least the children that attend public schools. The cookie present several advantages such as it can be made in different forms and flavors, children like them, and one cookie could satisfy a great proportion of the Recommended Dietary Allowance (RDA) of these nutrients.

In the case of vitamin A, it was designed that the cookie could provide at least 75% of RDA for children.

SLIDE 5

Vitamin A is sensible to light, humidity and heat. Therefore, it was necessary to determine the loss percentage of this nutrient before to expand the fortification of the nutritious cookie.

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The purpose of this work was to determine the stability of retinol during the baking process as well as through the shelf-life of the cookie, that is 45 days, in order to assess its relevance as a source of vitamin A.

SLIDE 6

Three batches of cookies were produced following the standard procedure, but Maisoy flour was fortified with a micronutrient premix that included retinyl palmitate (the encapsulated type), thiamine, niacin, riboflavin and iron.

It was determined the total retinol content of the fortified ingredients that in this case were Maisoy flour and sugar.

Cookies were baked, weighted and it was measured their retinol content in a subsample of just baked cookies.

They were packed in polyethylene bags and stored at INCAP in carton boxes at room temperature (25 centigrades degrees) and 70 to 80 percent of relative humidity .

Vitamin A and humidity content of the cookies were measured after 15, 30 and 45 days of storage.

SLIDE 7

Now you're going to see some photographs of the industrial process used to prepare the cookies. The same procedure was followed to prepare the cookies used in this study but at smaller scale.

After ingredients had been weighted they are mixed until it has been formed a firm and homogeneous dough. At this point the three types of flour are already mixed, including Maisoy flour that was previously fortified with the micronutrient premix.

SLIDE 8

When the dough is ready, the baker shapes the cookies and put them in trays, ready to be baked.

SLIDE 9

Cookies are baked in an oven at a temperature between 160 to 175 centrigrade degrees for 20 minutes.

SLIDE 10

When the product is finished, it is delivered and consumed.Here, you can see some children in a rural public school eating the cookie.

SLIDE 11

Prior to begin the study, with the purpose of developing and analytical assay to determine retinol in Maisoy flour and the nutritious cookie, several experiments were performed using High-performance liquid chromatography. The final analysis procedure included the following steps: (a) saponification of the sample with ethanolic potassium hydroxide to release retinol from the gelatin matrix of the beadlets and to hydrolyze retinol esters. (b) Then the solution is neutralized with acetic acid in acetonitrile and cleaning by centrifugation.

SLIDE 12

Retinol is extracted using a cartridge packed with a C18 resin. This is a vaccuum manifold used in our laboratory to process several samples at the same time.

SLIDE 13

After passing the sample through the cartridge, retinol is retained in it, while "hydrophilic" substances are eluted with an acetonitrile/water solution. Finally retinol is released from the cartridge with isopropyl alcohol.

SLIDE 14

This solution is injected in the chromatographer using methanol:water (97:3) as the mobile phase and a C18 column (150 x 4 mm I.D.) as the stationary phase using an UV/Vis detector at 325 nm. This is a typical chromatogram of the analysis of retinol in the cookie.

SLIDE 15

The initial retinol content of the Maisoy flour was 95 ug/g and the sugar had 2 ug/g. 0.57 kg of the Maisoy flour and 0.68 kg of sugar were used to produce 80 cookies per batch.

The average retinol content of the just baked cookies was 23 ug/g.

SLIDE 16

According to the mass balance 5197 ug were lost during baking, that is 9.5% of the initial retinol content then cookies retained 90.5 % of retinol.

SLIDE 17

During the shelf-life the cookies conserved 95, 83 and 76 % of its initial retinol content after 15, 30 and 45 days of storage, respectively. The loss of vitamin A coincides with the increment of humidity, from 4% at the beginning of the study to 6% at the end of the shelf life of the cookie. These data coincide with stability values reported for bread and other types of cookies. In our study, however, we followed the analysis for a much longer period of time than these studies.

Food Agriculture Organization and World Health Organization has indicated as the RDA of vitamin A for children the value of 400 RE. Then, to meet 75% this RDA with the cookie, the flour must contain 63 ug of retinol/gram. This amount was calculated based on the loss during the baking process and the shelf life.

SLIDE 18

The total cost of the cookie fortification with vitamin A in order to supply at least 75% RDA of this nutrient for children is US$95 per million cookies, that is 0.015 cents per child in a school year.

The total cost to fortificate with all the micronutrients before mentioned plus folic acid and vitamin b12, is 0.12 per child in a year and 0.0008 per cookie.

SLIDE 19

In conclusion the nutritionally-improved cookie is an excellent vehicle to provide vitamin A, with the only requirement that the cookie be consumed in a regular and continuos base.