

# Consumer Acceptability and Physicochemical Properties of Haitian Peanut Butter-Type Products (Mambas) Compared with U.S. Peanut Butter

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## ABSTRACT

Small-scale food processors in Haiti manufacture peanut butter-type products, locally called mambas. Mambas are prepared from ground, roasted peanuts, and may be flavored with sugar or pimiento peppers, but contain no stabilizers. This study compared acceptability by Haitian consumers and some physicochemical properties of mambas and U.S. peanut butter. Three types of mambas—Plain (no sugar or salt added), Sucre (with sugar and salt), and Pimente (with crushed pimiento peppers and salt)—and U.S. Crystal<sup>®</sup> smooth peanut butter were evaluated by 199 panelists ranging in age from 14 to 77 yr, and from three urban districts in Haiti. A randomized complete block design was used for the study. Samples in souffle cups were labeled with three-digit random codes. Panelists indicated their feelings about intensity levels of color, oily appearance, peanut flavor, sweetness, spiciness, and smooth mouth feel of the samples on five-point Just-About-Right scales. Color of the U.S. peanut butter (U.S.,  $h^{\circ} = 73.1 \pm 0.70$ , L value =  $58.9 \pm 0.60$ ) and mamba sucre (MS,  $h^{\circ} = 74.0 \pm 0.72$ , L value =  $57.6 \pm 0.74$ ) was considered Just-Right (JR) by 67 and 57% of panelists, respectively, but the mamba pimente (MP,  $h^{\circ} = 78.0 \pm 1.27$ , L value =  $60.4 \pm 2.21$ ) was too pale (63%). Oily appearance of all products was acceptable to 51-59% of the participants. The peanut flavor of U.S., MS, and MP was JR for 77, 80, and 74% of panelists, respectively, whereas it was too low in the plain mamba (M) for 41% of the panelists. Sixty-six and 67%, respectively, of panelists liked the sweetness of U.S. and MS, but M and MP were not sweet enough for 72 and 68%, respectively, of the panelists. Products U.S., MS, M, and MP contained  $9.4 \pm 0.29$ ,  $11.6 \pm 0.30$ ,  $4.7 \pm 0.08$ , and  $3.7 \pm 0.34\%$  sugar, respectively. Fifty-five percent of panelists indicated that the spiciness of MP was JR, whereas 82-92% felt that the other products were not spicy enough. Panelists (63-75%) felt that the products had an acceptable mouth feel, but MS and MP were liked the most (75%). Results indicate that Haitian consumers prefer mambas that have sweet and pimiento flavors to unflavored products.

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Key Words: Flavor, pimiento, sensory.

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Peanuts are grown throughout Haiti and contribute substantially to farm cash income, although they are not considered as one of the major crops. The major peanut-producing areas are the Plateau Central (centrally located), and Palmiste-a-Vin and Port-a-Piment in the southwestern part of the country. Valencia is the main type grown in the two former regions, whereas both valencia and virginia are grown in Port-a-Piment. Approximately 28,000 ha are cultivated to peanut, and the average annual production is 30,000 t (Jolly and Prophete, 1999). The average farm size is 1.7 ha. Less than 5% of the peanuts are consumed at the household level, 46.5% are sold immediately after harvest, and 44.9% are stored for subsequent sale. If peanuts are stored by the farmers and then sold 6 mo after harvest, the revenue generated almost doubles (Jolly and Prophete, 1999). The Haitian peanut marketing cooperative, CAPESEDO, buys peanuts from its members at harvest when prices are low, stores them for approximately 8 mo, then sells later in the year when prices rise due to market shortages (Pluiose and Hamlett, 1992). Farmers who belong to CAPESEDO have a higher average net revenue per marmite (Haitian unit of measure for peanuts: 1 marmite  $\approx$  3 lb) of peanuts produced than farmers who are not members of the cooperative.

Haiti is one of the poorest countries in the world (Pluiose and Hamlett, 1992). The Haitian population is increasing at an annual rate of approximately 2% and, thus, there are strong demands for food and raw materials (Gafar, 1998). Small-scale processing of peanuts contributes significantly in terms of value-added to Haitian household farm income. During recent years, small-scale food processors in Haiti have been manufacturing peanut butter-type products, locally called mambas. Mambas are prepared from ground, roasted peanuts and may be flavored with sugar, salt, or pimiento peppers (*Capsicum annum* L.) but contain no stabilizers. On the local market, mambas compete with imported U.S. peanut butter.

In the U.S., researchers have evaluated quality of peanut butter flavored with milk chocolate (Wong *et al.*, 1999), nonfat dried milk (Pominski *et al.*, 1991), and with honey (Hashim and Resurreccion, 1995). Peanut butter containing a 9:1 ratio of peanuts:wheat germ has been prepared successfully in China (Sorto *et al.*, 1999). However, there are no previous reports on peanut butter products containing pimiento peppers.

The objectives of this study were to evaluate acceptability of important quality attributes of plain and flavored mambas by Haitian consumers and to compare their acceptability and quality with imported U.S. peanut butter. Traditionally, U.S. peanut butter is the only product of this type to which Haitian consumers have

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been exposed. Thus, comparison of the mambas with a popular imported U.S. brand of peanut butter would provide information to determine how the mambas might be enhanced to increase sales on the Haitian market.

## Materials and Methods

**Products.** Various brands of mambas sold in several supermarkets in Haiti were screened. The products that were selected for the study represented the spectrum of quality attributes displayed by the various local brands. They were (a) Tacha Mamba [plain—with no added sugar (sucrose) or salt (sodium chloride), Les Produits Tacha, Port-au-Prince], Gerdy Mamba Sucre (with added sugar and salt, Gerdy, Port-au-Prince), and Topla Mamba Pimente [with added crushed pimiento peppers and salt (L'association des paysans de Vallée, Petit-Goave)]. U.S.-manufactured Crystal® smooth Peanut Butter [ingredients: peanuts, dextrose, hydrogenated vegetable oil, and salt (Crystal International Corp, Inc., New Orleans, LA)], the most popular imported brand, was used as the control.

**Recruiting of Consumer Panelists.** Fieldwork was carried out in Haiti in July 2000. Panelists were recruited from three urban districts in the southwestern part of the country—Kenscoff (45), Canape Verde (90), and Pernier (64). Approximately 95% of the panelists were functionally illiterate. One to 2 d prior to the testing, panelists were explained the test protocol, and relevant demographic and socio-economic information was solicited after they had consented verbally to participate in the study. All panelists ate peanut butter or mamba at least once per month.

**Experimental Design and Testing Instruments for Sensory Study.** A randomized complete block design for a four-product test (Stone and Sidel, 1993) was used in which each panelist (block) evaluated all four products (one peanut butter and three mambas) in one session. Central location tests were conducted in Kenscoff, Canape Verde, and Pernier. The Affective Sensory Evaluation Method (Stone and Sidel, 1993) was employed. Five-point Just-About-Right Scales were used to evaluate the following quality attributes of the mambas—color, appearance (oily/dry), peanut flavor, sweetness, spiciness, and mouth feel. The midpoint of each scale (3) represented the just-about-right level for the particular attribute. Points 1 and 2 on the scale indicated that the intensity was much too low, and a little too low, respectively; whereas points 4 and 5 indicated that the intensity level was a little too high, and much too high, respectively. Panelists were asked to indicate their feelings about the intensity levels of each attribute on a separate scale. Testing instruments (score sheets) were translated from English to French to facilitate training of the Haitian technical assistants/interpreters, and to Creole (Haitian dialect) for use by the panelists.

**Sensory Evaluation.** Sensory evaluation was carried out in Haiti in July 2000. Products were evaluated under natural daylight conditions. Samples were placed in 30-mL plastic soufflé cups with lids and labeled with three-digit random codes. Samples and score sheets were presented

monadically to each panelist. Panelists were required to rinse their mouths with water before evaluating each sample. The interpreters assisted illiterate panelists with reading and marking of the score sheets.

**Physical Tests.** To measure color attributes, three jars of each product were randomly selected, their contents were stirred, and air bubbles were pressed out (Hinds *et al.*, 1994). Three measurements per sample were taken using a Minolta Chroma Meter Reflectance System (Model C12-2000, Minolta, Japan) set in the CIE L\*C\*h\* mode with illuminator C at 2° observer angle. Calibration was based on a white tile with color space chromaticity coordinates: L\* = 97.75, a\* = -0.58, and b\* = +2.31.

Three randomly selected jars from each product, held undisturbed at room temperature (21–22 C), were used for texture evaluation. Firmness and adhesiveness of each sample were evaluated using a TA.XT2i Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK) fitted with a 25-mm diam. flat-ended, acrylic cylindrical probe (TA-3) and a 25-kg load cell. Measurements were taken using the Texture Expert Exceed Software with the following settings: pretest speed = 10.0 mm/sec, test speed = 1.0 mm/sec, post-test speed = 1.0 mm/sec, penetration distance into the sample = 5.0 mm, and force = 5 g. Force-deformation curves during probe penetration and withdrawal were obtained. Firmness of samples was interpreted as the peak force (g) during penetration and adhesiveness of the samples as the work (g\*mm) required to overcome the attractive forces between the sample and probe surface and, thereby, remove the sample from the probe surface.

**Lipid and Sugar Analyses.** Three jars of each product were selected randomly. The contents of each jar were blended separately (Oster™ kitchen blender) to homogenize oil or any other ingredients that might have separated during storage. Aliquots, 150-g, from each homogenized sample, were individually bagged (Fisherbrand™ sterile sampling bags) for transport to the analytical lab. The methods of McBee and Maness (1983) and Russo *et al.* (1998) were used as guidelines for lipid extraction and sugar analysis (HPLC) on these samples.

Prior to subsampling for lipid extraction, the contents of each bag were evenly spread and mixed on a pie plate to assure homogeneity. Duplicate samples of 100 mg each were weighed into 2-dram screw-cap clear glass vials. A small magnetic stirrer was inserted, and lipids were extracted at room temperature inside a fume hood with 2 mL of anhydrous ethyl ether after sealing vials with Teflon-lined caps with stirring for 20 min. Vials were then centrifuged in a Speed-Vac centrifuge (Savant, Inc., Holbrook, NY) for 15 min and the supernatant was placed into a tared 2-dram screw-cap clear glass vial. The extraction was conducted three more times for a total of four extractions. The combined supernatant fractions were evaporated overnight inside the tared and uncapped 2-dram vials without additional heat using a Speed-Vac sample concentration system during centrifugation using a -100 C cold trap and down line organic vapor trap with vacuum at 200 to 500 millitorr. Total lipids were quantitated gravimetrically and expressed as a percentage of the sample starting weight. During preliminary trials, a commercial peanut butter (of known oil content) was

extracted with or without spiking with vegetable oil, and lipid recoveries were between 97 and 102% (w/w). Defatted samples were uncapped and dried overnight to remove residual ether with the Speed-Vac sample concentration system described above and subsequently utilized for sugar extraction.

Following removal of residual ethyl ether, sugar extractions were conducted inside the same 2-dram vials used for lipid extraction. A reflux tube apparatus was constructed by placing a Pasteur pipette through a Teflon-lined silicon cap liner and fitting into an open-top cap for the 2-dram vial. The pipette was allowed to protrude into the vial approximately the same distance as the screw cap. Upon sealing of the cap, the pliable silicon liner effectively sealed around the pipette. For sugar extraction, 2 mL of 95% (v/v) ethanol was added, the vials were capped with the reflux apparatus, and vials were placed into a dry block heater at 80 C. After the ethanol had started to boil, samples were extracted for 20 min with intermittent stirring by rotation of the reflux tubes approximately every 5 min. Following extraction, the reflux apparatus was removed and samples were centrifuged in a Speed-Vac centrifuge for 10 min. The supernatant was removed and placed into a labeled 10-mL volumetric flask. The extraction was conducted three more times for a total of four extractions. The combined supernatants were brought to volume with 95% (v/v) ethanol, placed into a capped brown bottle, and stored at 4 C for 1 wk or less prior to sugar analysis. Preliminary spiking trials with or without additional sucrose added prior to lipid extraction were conducted, with recoveries of 95 to 101% (w/w).

Sucrose, fructose, and glucose were quantitated in samples using a Dionex DX-500 HPLC system with a gradient pump module, a pulsed electrochemical detector in pulsed amperometry mode, and a Peak-Net data station (Dionex Corp., Sunnyvale, CA). Samples were injected automatically by overfilling a 50- $\mu$ L injection loop with an AS-3500 autosampler. A CarboPac PA-1 column (4 mm  $\times$  250 mm), also from Dionex, was used for separations under isocratic conditions of 92% water and 8% 0.5 M NaOH over a duration of 20 min. Ethanol extracts (10 to 100  $\mu$ L) were placed into screw-cap autosampler vials, ethanol was evaporated in a Speed-Vac sample concentration system, and sugars were dissolved into 1 mL of HPLC grade water. Separations were conducted at a flow rate of 1 mL min<sup>-1</sup>. Following every 12 injections, carbonate buildup on the column was removed with a 50% water, 50% 0.5 M NaOH rinse at a flow rate of 1 mL min<sup>-1</sup>, and over a duration of 30 min. The column was allowed to re-equilibrate at isocratic conditions for 30 min prior to injection. Sucrose, fructose, and glucose were identified by coelution with authentic standards and quantified using a 4-nM standard. Levels of sugars were expressed as a percentage of the starting sample weight.

**Statistical Analysis.** Data were analyzed using the SAS Inst., Inc. (1997) Computer Package (PC versions 6.12 and 8.1 for Microsoft Windows™). The GLM procedure was used to compute ANOVA. Significant differences between means were tested using the LSD method. Frequencies and the influence of demographic variables (chi square tests) on acceptability of the products were determined.

## Results and Discussion

**Panelists Profile.** A total of 199 panelists ranging from 14 to 77 yr participated in the study. There were a total of 101 males and 98 females. Age groups 14-20, 21-30, 31-40, 41-50, and above 50 yr, respectively, had 48, 64, 38, 26, and 23 participants. Monthly income distribution of the panelists was as follows: 55.3, 14.6, 8.5, 5.0, 6.5 and 10.0% of the panelists earned <400, 400-799, 800-1199, 1200-1599, 1600-2000, and >2000 gourdes per month, respectively (17 gourdes = U.S. \$1 at the time of the study).

**Color.** The mamba pimente had a significantly ( $P < 0.05$ ) less intense and paler brown hue ( $h^{\circ} = 78.0 \pm 1.27$ , chroma =  $26.1 \pm 0.17$ ) than the other products ( $h^{\circ} = 73.0 \pm 0.26$ - $74.0 \pm 0.72$ , chroma =  $29.5 \pm 0.92$  -  $31.0 \pm 0.73$ ) and was significantly ( $P < 0.05$ ) lighter (L value =  $60.4 \pm 2.21$ ) than the mamba sucre (L value =  $57.6 \pm 0.74$ ; Table 1). Although mean scores ( $2.6 \pm 0.80$ ) assigned to the U.S. peanut butter indicated that its color was significantly ( $P < 0.05$ ) more acceptable than that of the Haitian brands ( $2.1 \pm 0.94$  -  $2.5 \pm 0.83$ ), panelists considered all products to be a little too light (Table 2). The mamba pimente was perceived to be the lightest in color ( $2.1 \pm 0.94$ ; Table 2) and was considered to be too light and just right by 62.9 and 34.0% of the panelists, respectively (Table 3). On the other hand, the U.S. product was just right in color for 67.3% of the panelists, whereas 27.7% considered it to be too pale (Table 3). Among the mambas, the mamba sucre's color was the most acceptable (Table 3), but only to 57.1% of the panelists. This indicates that Haitian processors may need to use darker roasted nuts to obtain products with L values and hue angles that are less than 57.6 and 74.0, respectively.

Gender of the Haitian panelists was not a major factor influencing acceptability of color of products, except for the U.S. peanut butter which was considered just right by 72.9% of females vs. 62.8% of males, and too dark by 1.0% of females vs. 8.8% of males (Table 4). Generally, panelists in the 14-20 age group tended to prefer a darker product than panelists who were 50+ years (Table 5). For example, 42.6 and 55.3% of the 14-20-yr olds vs. 34.8 and 65.2% of the 50+-yr panelists considered the mamba sucre to be too pale, and just right, respectively. In the case of the mamba pimente, the palest product, 50% of the 50+-yr panelists thought the color was just right, whereas 30-34% of all the younger panelists considered it too pale (Table 5).

**Appearance.** The plain ( $3.2 \pm 0.91$ ) and sucre ( $3.2 \pm 0.94$ ) mambas received similar mean scores to the U.S. product ( $3.0 \pm 0.94$ ) for oily/dry appearance (Table 2) indicating that their average appearance was just right. The mamba pimente was perceived to have a drier appearance ( $2.8 \pm 1.08$ ) than the other products, and was considered too dry by 30.2% of the panelists compared with 13.0-18.9% who considered the other products too dry (Table 3). The plain and sucre mambas were considered too oily by 28.0 and 31.8% of the panelists, respectively. There appears to be no correlation between lipid content of the products and the perception of degree of oil/dry appearance on the part of the panelists. Mamba pimente contained significantly more oil ( $48.7 \pm 0.67$ ) than the other two Haitian products ( $43.9 \pm 0.51$  -  $46.4 \pm 0.82$ ) but less than that of the U.S. brand ( $52.1$

**Table 1. Physicochemical properties (means ± s.d.)<sup>a</sup> of peanut butter and mambas.**

Physicochemical properties	U.S. <sup>b</sup>	Plain <sup>c</sup>	Sucre <sup>c</sup>	Pimente <sup>c</sup>
Color:				
L value <sup>d</sup>	58.9±0.60 ab	59.7±0.66 ab	57.6±0.74 b	60.4±2.21 a
Hue angle <sup>e</sup>	73.1±0.70 b	73.0±0.26 b	74.0±0.72 b	78.0±1.27 a
Chroma <sup>f</sup>	30.5±0.74 ab	31.0±0.73 a	29.5±0.92 b	26.1±0.17 c
Texture:				
Firmness (g)	7.6±5.76 a	5.6±0.87 a	4.4±0.65 a	5.0±1.38 a
Adhesiveness (g*mm)	140.2±64.14 a	10.6±2.24 b	4.6±4.01 b	5.6±2.69 b
Crude lipid (% , as-is basis)	52.1±0.88 a	46.4±0.82 c	43.9±0.51 d	48.7±0.67 b
Sucrose (% , as-is basis)	9.4±0.29 b	4.7±0.08 c	11.6±0.30 a	3.7±0.34 d

<sup>a</sup>ANOVA: Means for the same physicochemical property (row) followed by a different letter are significantly different (P < 0.05).

<sup>b</sup>U.S.-manufactured peanut butter.

<sup>c</sup>Peanut butter-type products (mambas) manufactured in Haiti.

<sup>d</sup>L value: lightness/darkness scale (0 = black, 100 = white).

<sup>e</sup>Hue angle: color descriptor (0° = red, 90° = yellow).

<sup>f</sup>Chroma: intensity of the hue.

**Table 2. Acceptability<sup>a</sup> (means ± s.d.) of peanut butter and mambas.**

Attributes	Acceptability scores <sup>b</sup>			
	U.S. <sup>c</sup>	Plain <sup>d</sup>	Sucre <sup>d</sup>	Pimente <sup>d</sup>
Color	2.6±0.80 a	2.4±0.94 b	2.5±0.83 b	2.1±0.94 c
Appearance	3.0±0.94 a	3.2±0.91 a	3.2±0.94 a	2.8±1.07 b
Peanut flavor	2.8±0.68 b	2.1±1.01 c	2.9±0.66 ab	3.0±0.75 a
Sweetness	2.9±0.87 a	1.8±0.96 b	2.8±0.87 a	1.8±1.03 b
Spiciness	1.5±0.78 b	1.3±0.60 c	1.5±0.86 b	3.5±1.09 a
Mouth feel	2.5±0.78 c	2.5±0.84 bc	2.7±0.67 b	3.0±0.63 a

<sup>a</sup>Acceptability scale: 1 = much too low, 2 = a little too low, 3 = just about right, 4 = a little too high, 5 = much too high.

<sup>b</sup>ANOVA: Means for the same parameter followed by a different letter are significantly different (P < 0.05).

<sup>c</sup>U.S.-manufactured peanut butter.

<sup>d</sup>Peanut butter-type products (mambas) manufactured in Haiti.

± 0.88; Table 1). The perceived dry appearance of the mamba pimente may have been due to the ground pimienta peppers in its formulation. Paprika, an emulsifier, is obtained from ground, dried pimienta peppers. Grinding of the pimienta peppers to prepare the mamba pimente also could give rise to bipolar molecules (similar to those in paprika) capable of emulsifying the oil in the mamba and thereby contribute to its relatively dry appearance.

In a previous study evaluating quality attributes of peanut butter products manufactured in Belize (Central America), in which all the products contained stabilizers, the local products were thought to be significantly (P < 0.05) more oily in appearance (3.7-4.3) than the control (3.2) (Hinds *et al.*, 1995b) by 47.6-68.2% of the panelists (Hinds *et al.*, 1995a). Because the Haitian products contained no stabilizers, the comparison suggests that Belizean consumers find oil separation less acceptable than Haitian consumers.

All products received more just right scores from

**Table 3. Frequency (%) of responses for attributes of peanut butter and mambas (N = 199).**

Attribute	Products			
	U.S. <sup>a</sup>	Plain <sup>b</sup>	Sucre <sup>b</sup>	Pimente <sup>b</sup>
Color				
Too light	27.7	45.6	40.3	62.9
Just about right	67.3	47.7	57.1	34.0
Too dark	5.0	6.7	2.5	3.0
Appearance				
Too dry	18.9	13.0	13.4	30.2
Just about right	57.7	59.1	54.9	50.5
Too oily	23.5	28.0	31.8	19.3
Peanut flavor				
Too low	18.3	55.7	14.8	13.8
Just about right	76.6	40.7	79.6	74.0
Too high	5.1	3.6	5.6	12.3
Sweetness				
Too low	20.0	71.6	21.2	68.4
Just about right	66.2	25.4	67.4	28.6
Too high	13.9	3.0	11.4	3.0
Spiciness				
Too low	82.1	92.3	82.4	8.6
Just about right	17.9	7.7	15.6	55.3
Too high	0.0	0.0	2.0	36.1
Mouth feel				
Too smooth	36.0	33.0	23.0	12.9
Just about right	64.0	62.9	75.0	74.7
Too grainy	0.0	4.0	2.0	12.4

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

females than males (Table 4). Although the mamba pimente gained similar percent scores for dryness from males and females, 25.2% of males vs. 13.0% of females considered it to be too oily (Table 4). Generally, appearance of the products was favored more by panelists who were ≥ 21 yr than by the younger panelists (Table 6). Panelists who were ≤ 20 yr thought the products looked

**Table 4. Influence of panelists gender on acceptability (frequency %, N = 199) of quality attributes of peanut butter and mambas.**

Attribute		Products							
		U.S. <sup>a</sup>		Plain <sup>b</sup>		Sucre <sup>b</sup>		Pimente <sup>b</sup>	
		M <sup>c</sup>	F <sup>c</sup>	M <sup>c</sup>	F <sup>c</sup>	M <sup>c</sup>	F <sup>c</sup>	M <sup>c</sup>	F <sup>c</sup>
Color	Too light	28.4	26.0	46.5	44.7	40.4	40.2	63.0	62.9
	Just about right	62.8	72.9	45.4	50.0	56.6	57.7	32.0	36.2
	Too dark	8.8	1.0	8.1	5.3	3.0	2.1	5.0	1.1
Appearance	Too dry	21.8	14.9	19.4	6.3	16.3	11.3	31.3	30.1
	Just about right	54.5	61.7	54.1	64.2	46.9	62.9	44.4	57.0
	Too oily	33.8	23.4	26.5	29.5	37.7	25.9	25.2	13.0
Peanut flavor	Too low	23.0	12.5	60.0	51.2	15.3	14.3	16.7	10.6
	Just about right	70.0	84.4	35.0	46.8	78.6	80.6	68.6	79.8
	Too high	7.0	3.1	5.0	2.1	6.1	5.1	14.7	10.6
Sweetness	Too low	16.8	22.6	67.3	76.0	25.2	17.0	65.3	71.6
	Just about right	68.3	64.5	29.7	20.8	60.6	74.5	30.7	26.3
	Too high	14.8	12.9	3.0	3.1	14.1	8.5	4.0	2.1
Spiciness	Too low	84.0	79.8	94.1	90.5	88.1	76.5	12.7	4.2
	Just about right	16.0	20.2	5.9	9.5	11.9	19.4	57.8	52.6
	Too high	0.0	0.0	0.0	0.0	0.0	4.0	29.4	43.1
Mouth feel	Too smooth	34.3	37.1	37.3	28.4	24.7	21.0	13.0	12.9
	Just about right	65.7	62.9	56.9	69.5	72.3	77.9	73.0	76.6
	Too grainy	0.0	0.0	5.9	2.1	3.0	1.0	14.0	10.6

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

<sup>c</sup>M, F = frequency (%) of scores assigned by male and female panelists, respectively.

**Table 5. Influence of panelists age on acceptability (frequency %, N = 199) of color of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too pale	33.3	23.4	26.3	26.9	27.3
	Just right	58.3	73.4	63.2	73.1	72.7
	Too dark	9.3	3.1	10.5	0.0	0.0
Plain <sup>b</sup>	Too pale	47.9	44.3	44.7	47.8	43.5
	Just right	47.9	49.2	44.7	47.8	47.8
	Too dark	5.2	6.5	10.5	4.4	8.7
Sucre <sup>b</sup>	Too pale	42.6	45.3	30.7	43.5	34.8
	Just right	55.3	51.6	64.1	56.5	65.2
	Too dark	2.1	3.1	5.1	0.0	0.0
Pimente <sup>b</sup>	Too pale	66.0	65.6	66.7	60.0	45.4
	Just right	30.0	34.4	30.6	32.0	50.0
	Too dark	4.2	0.0	2.8	8.0	4.6

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

more oily than panelists who were > 50 yr old (Table 6).

**Peanut Flavor.** The peanut flavors in the U.S. peanut butter and the sucre and pimente mambas were found to be just about- right ( $2.8 \pm 0.68$  to  $3.0 \pm 0.75$ ; Table 2), whereas the peanut flavor of the plain mamba was a little too low ( $2.1 \pm 1.01$ ; Table 2). Only 40.7% of the panelists considered the

peanut flavor of the plain mamba to be just right compared with 74.0-79.6% for the other products (Table 3).

In the Belizean study, all the local products were thought to have significantly ( $P < 0.05$ ) lower peanut flavor (2.0-2.8) than the control (3.2) (Hinds *et al.*, 1995b). Vegetable oil, water, or molasses had been added to the Belizean formula-

**Table 6. Influence of panelists age on acceptability (frequency %, N = 199) of appearance (dry/oily) of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too dry	20.8	19.0	24.3	7.7	14.3
	Just right	50.0	54.0	48.6	80.8	76.2
	Too oily	29.2	27.0	27.0	11.5	9.5
Plain <sup>b</sup>	Too dry	22.9	9.8	10.8	12.5	4.3
	Just right	50.0	62.3	62.2	54.2	69.6
	Too oily	27.1	27.9	27.0	33.3	26.1
Sucre <sup>b</sup>	Too dry	15.5	17.2	7.7	16.0	4.5
	Just right	42.2	48.4	56.4	64.0	86.4
	Too oily	42.2	34.4	36.9	20.0	9.1
Pimente <sup>b</sup>	Too dry	34.8	32.8	23.5	36.0	17.4
	Just right	39.1	51.6	58.8	52.0	56.5
	Too oily	26.1	15.6	17.6	12.0	25.1

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

tions whereas the Haitian products did not contain these ingredients. Instrumental analyses were not carried out to determine intensity of roasted peanut flavor in the Haitian products. The weaker peanut flavor perceived in the plain mamba might be due to the lack of added sugar or salt to enhance the peanut flavor or might have arisen from the use of a different type of peanut or other differences in processing operations.

More females than males gave just right scores for peanut flavor to the products (Table 4). The plain mamba was considered too low in peanut flavor by 60% of the males vs. 51.2% of the females (Table 4). Generally, the younger panelists preferred a stronger peanut flavor (Table 7). For example, 73.3 and 34.8%, respectively, of the 14-20-yr and 50+-yr plus panelists felt that the peanut flavor of the plain mamba was too low compared with 24.4 and 60.9%, respectively, who felt it was just right (Table 7).

**Sweetness.** None of the products contained fructose. Although the label of the U.S. peanut butter indicates that it contains dextrose (dextrorotatory glucose), only one of its nine samples contained 0.02% glucose. Thus, the sugar content of the products is discussed in terms of sucrose only. The U.S. product ( $9.4 \pm 0.29\%$  sucrose) and mamba sucre ( $11.6 \pm 0.30\%$  sucrose) were significantly ( $P < 0.05$ ) sweeter than the other two Haitian brands ( $3.7 \pm 0.34$  and  $4.7 \pm 0.08\%$  sucrose; Table 1), and the panelists considered their sweetness to be almost just about right ( $2.9 \pm 0.87$  and  $2.8 \pm 0.87$ , respectively; Table 2). Mean sweetness scores assigned to the plain ( $1.8 \pm 0.96$ ) and pimente ( $1.8 \pm 1.03$ ) mambas (Table 2) indicated that they were not sweet enough for 71.6 and 68.4%, respectively, of the panelists (Table 3). Only 25.4 and 28.6% of the panelists, respectively, felt that the plain and pimente mambas were sweet enough. These results indicate that Haitian mambas need to contain 9.4-11.6% sucrose to facilitate their acceptability. In the Belizean study, the local product that contained brown sugar and molasses was considered too sweet (3.8) compared with the others (2.0-2.6) which were sweetened with white sugar only (Hinds *et al.*, 1995a,b).

Generally, the responses to sweetness showed similar

**Table 7. Influence of panelists age on acceptability (frequency %, N = 199) of peanut flavor intensity of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too weak	20.6	20.6	15.8	12.0	13.0
	Just right	72.3	74.6	78.9	80.0	87.0
	Too strong	6.4	4.8	5.3	8.0	0.0
Plain <sup>b</sup>	Too weak	73.3	57.1	55.3	40.0	34.8
	Just right	24.4	38.1	44.7	52.0	60.9
	Too strong	2.2	4.8	0.0	8.0	4.3
Sucre <sup>b</sup>	Too weak	19.1	19.3	12.8	12.0	0.0
	Just right	76.6	77.4	76.9	80.0	95.6
	Too strong	4.3	3.2	10.3	8.0	4.4
Pimente <sup>b</sup>	Too weak	15.2	12.5	18.9	7.7	13.0
	Just right	65.2	75.0	70.3	88.5	78.3
	Too strong	19.6	12.5	10.8	3.8	8.7

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

trends from both male and female panelists (Table 4). However, 60.6% of males vs. 74.5% of females considered the mamba sucre to be just right. Only 29.7 and 30.7% of males, and 20.8 and 26.3% of females, respectively, indicated that the plain and pimente mambas were sweet enough. On the other hand, 67.3 and 65.4% of males and 76.0 and 71.6% of females felt that the plain and pimente mambas, respectively, were not sweet enough (Table 4). Although the U.S. product and the mamba sucre received overall similar just right scores for sweetness, panelists in the 14-40-yr range preferred the sweetness of the mamba sucre whereas the 41+-yr panelists preferred the U.S. product (Table 8). A greater percentage of the panelists  $\leq 40$  yr than those  $> 40$  yr considered the (less sweet) plain and pimente mambas not sweet enough (Table 8). These findings suggests that Haitian consumers who are  $< 40$  yr prefer sweeter products. Conjoint analysis of the data indicated that sweetness was the most important quality attribute influencing purchase intent of the products (Nelson *et al.*, 2001).

**Table 8. Influence of panelists age on acceptability (frequency %, N = 199) of sweetness of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too low	31.9	20.6	21.0	0.0	8.7
	Just right	57.4	68.2	57.9	82.6	78.3
	Too high	10.6	11.1	21.0	17.4	13.0
Plain <sup>b</sup>	Too low	75.0	64.6	89.5	52.0	48.8
	Just right	22.9	20.6	10.5	48.0	43.5
	Too high	2.1	4.8	0.0	0.0	8.8
Sucre <sup>b</sup>	Too low	21.7	24.2	13.5	23.1	22.7
	Just right	65.2	69.3	78.4	57.7	59.1
	Too high	13.0	6.4	8.1	19.2	18.2
Pimente <sup>b</sup>	Too low	78.3	67.2	70.3	61.5	56.5
	Just right	19.6	29.7	27.0	34.6	39.1
	Too high	2.2	3.1	2.7	3.8	4.3

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

**Pimiento Flavor.** Mean scores indicate that all products, except the mamba pimente, were not spicy enough (1.3-1.5; Table 2). Eighty-two percent of all panelists indicated that the spicy flavors of the U.S. peanut butter and the sucre mamba were too low, but 92.3% felt that the plain mamba was not spicy enough (Table 3). On the other hand, 55.3 and 36.1% felt that the spicy flavor of the pimente mamba was just about right, and too high, respectively (Table 3).

Response to spiciness was not affected by gender of panelists for all products except the pimente mamba where males seemed to prefer a more spicy product (Table 4). Thirteen percent of males and 4.2% of females indicated that the pimente mamba was not spicy enough compared with 29.4% of males and 43.1% of females who felt that it was too spicy. Fifty-eight percent of males and 52.6% of females found the spiciness of the pimente mamba to be just about right (Table 4). Age was also a factor influencing

acceptability of spiciness (Table 9). Seventy percent and 65.4%, respectively, of persons 31-40 and 41-50 yr old indicated that the spiciness of the pimente mamba was just about right compared with 51.1, 46.9, and 47.8%, respectively, of panelists who were 14-20, 21-30, and 50+ yr old. However, 21.7% of the 50+-yr panelists felt that the mamba pimente was not spicy enough. All the other products were considered not spicy enough by 76.9-91.3% of all age groups (Table 9), indicating that the average Haitian consumer desires a pimiento-flavored product.

**Texture and Mouth Feel.** Instrumental analysis indicated that there was no significant ( $P < 0.05$ ) difference in firmness among the products (Table 1). However, the U.S.

**Table 9. Influence of panelists age on acceptability (frequency %, N = 199) of spiciness of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too low	83.3	79.4	83.8	73.9	91.3
	Just right	16.7	20.6	16.2	26.1	8.7
	Too high	0.0	0.0	0.0	0.0	0.0
Plain <sup>b</sup>	Too low	97.9	91.9	89.5	88.0	91.3
	Just right	2.1	8.1	10.5	12.0	8.7
	Too high	0.0	0.0	0.0	0.0	0.0
Sucre <sup>b</sup>	Too low	79.2	85.9	76.9	80.0	91.3
	Just right	20.8	12.5	17.9	16.0	8.7
	Too high	0.0	1.6	5.1	4.0	0.0
Pimente <sup>b</sup>	Too low	6.4	7.8	2.7	11.5	21.7
	Just right	51.1	46.9	73.0	65.4	47.8
	Too high	42.5	45.3	24.3	23.1	30.4

<sup>a</sup>U.S.-manufactured peanut butter.

peanut butter ( $140.2 \pm 64.14$  g\*mm) was significantly more adhesive than the others ( $5.6 \pm 2.69$  -  $10.6 \pm 2.24$  g\*mm), indicating that it would cling to the tongue, teeth, and roof of mouth to a greater extent (Table 1). Adhesiveness of the products was not evaluated by the panelists.

The smoothness of the mamba pimente was just right ( $3.0 \pm 0.63$ ), whereas the other products were a little too smooth ( $2.5 \pm 0.78$  -  $2.7 \pm 0.67$ ; Table 2). Seventy-five percent of the panelists felt that the pimente and sucre mambas had just right mouth feel, whereas 33 and 36%, respectively, felt that the plain mamba and the U.S. peanut butter were too smooth (Table 3). Objective evaluation of smoothness was not carried out. To perform this test, dollops of the products would have had to be removed from the containers to be subjected to compression tests between plates. The Haitian products, especially the plain and sucre mambas, displayed a high degree of physical instability (oil separation at the surface) and, thus, could not be appropriately subjected to compression tests. However, the differences in mouth feel perceived by the panelists and their preference for the sucre and pimente could have arisen from several scenarios. The sucre mamba contained significantly less oil than the other products (Table 1) and, thus, might not have imparted as smooth a mouth feel. The pimente mamba contained ground pimiento which had visibly larger particle sizes than the ground roasted peanuts (imparting a more grainy mouth feel) and which also could have decreased the proportion of free oil in the product by emulsification.

In the Belizean study, mouth feel was the major quality attribute that influenced acceptability and purchase intent of the products (Hinds *et al.*, 1995b). The product that was too smooth was not accepted, although its peanut flavor and color were considered just right (Hinds *et al.*, 1995a,b).

Scores assigned to mouth feel were generally not influenced by gender of panelists, except for the plain mamba where more females than males (69.5 vs. 56.9%) considered it just right, but more males than females (37.3 vs. 28.4%) considered it too smooth (Table 4). A larger percent of the 14-30-yr-old panelists felt that the products were too smooth compared with a larger percent of the 31+-yr panelists who considered them just right (Table 10). The mamba pimente gained the highest percent of 'too grainy' scores from all age groups (Table 10), suggesting that the pimiento peppers should be ground more finely.

**Table 10. Influence of panelists age on acceptability (frequency %, N = 199) of mouth feel of peanut butter and mambas.**

Product	Response	Frequency (%) of scores by age (yr) of panelists				
		14-20	21-30	31-40	41-50	50+
U.S. <sup>a</sup>	Too smooth	43.7	45.3	39.5	15.4	8.7
	Just right	56.3	54.7	60.5	84.6	91.3
	Too grainy	0.0	0.0	0.0	0.0	0.0
Plain <sup>b</sup>	Too smooth	37.5	40.3	31.6	26.9	13.2
	Just right	52.1	56.4	65.8	73.1	86.9
	Too grainy	10.4	3.2	2.6	0.0	0.0
Sucre <sup>b</sup>	Too smooth	32.9	25.4	17.9	16.7	12.8
	Just right	65.9	73.0	79.5	79.2	87.0
	Too grainy	2.1	1.6	2.6	4.2	0.0
Pimente <sup>b</sup>	Too smooth	26.7	14.1	5.6	3.8	4.3
	Just right	51.1	81.2	75.0	84.6	91.3
	Too grainy	22.2	4.7	19.4	11.5	4.3

<sup>a</sup>U.S.-manufactured peanut butter.

<sup>b</sup>Peanut butter-type products (mambas) manufactured in Haiti.

## Summary and Conclusions

The U.S. peanut butter was most similar to the sucre mamba—acceptability scores were not significantly different in the attributes of appearance, peanut flavor, sweetness, and spiciness. The U.S. peanut butter differed from all the Haitian mambas in that it had the most acceptable color, whereas the Haitian products were considered a little too pale. A darker roast during mamba preparation would probably enhance color and peanut flavor of the products. The U.S. peanut butter imparted too smooth a mouth feel, indicating that Haitian consumers either prefer products with less oil or a coarser grind. Generally, the Haitian consumers prefer sweet- and pimiento-flavored mambas to unflavored mamba. The level of sugar in the pimente mamba needs to be increased to improve its acceptability. Consumers who are  $\leq 40$  yr tend to prefer a sweeter product, whereas those 31 yr and older tend to prefer a pimiento-flavored product. The information generated in this research is important to Haitian peanut processors in general, but particularly to those processors who want to target market segments with age and taste differences. The findings also have implications for U.S. and international peanut proces-

sors who may wish to include ethnic flavors in peanut butter products to facilitate market expansion.

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