DETERMINATION OF EGG CONTENT OF NOODLES—AN EVALUATION OF RESULTS OBTAINED BY DIFFERENT PROCEDURES

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ABSTRACT

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Results obtained with different analyses demonstrate that the percentage of egg yolks and whites—and thus of whole eggs—in noodles can be determined accurately only by using at least two procedures. The first must supply the percentage of yolk content by analyzing constituents, ie, cholesterol and fatty acids. The second must provide analogous data on white content by analyzing constituents, ie, conalbumin. The influence of the type of milled product on the results obtained by analyzing yolk constituents is also discussed.

Sensitive, specific methods have been developed for determining the percentage of egg in noodles. No method allows simultaneous evaluation of the percentage of yolk and white contents, but the methods are specific for determining the percentage of either the yolk or the white.

The analytic procedures involve either electrophoretic (1,2) or immunologic (3) evaluation of certain protein fractions of the egg white or quantitative determination of various components of the yolk, ie, determinations of cholesterol and its relationship to the phytosterols from milled products with which the noodles are made (4–7), of the percentage of fatty acids and their interrelationships (8,9), and of lecithinic phosphorous (10–13).

We performed a series of studies on specially prepared samples so that we could compare the results of the analytic procedures, verify the influence of the matrix (the type of milled product) on the results, and obtain information concerning commercial noodles and also so-called fresh noodles, which generally are prepared with soft wheat flour.

MATERIALS AND METHODS

Three sets of samples were prepared. These were:

- Commercial durum wheat semolina with zero to four whole eggs per kilo of finished product (0, 5, 10, 15, and 20%, respectively). Samples were identified as S_0, S_1, S_2, S_3, and S_4.
- Commercial soft wheat flour with zero to four whole eggs per kilo of finished product (0, 5, 10, 15, and 20%, respectively). Samples were identified as F_0, F_1, F_2, F_3, and F_4.
- A mixture of durum and soft wheat commercial products (70% + 30%), with zero to four whole eggs per kilo of finished products (0, 5, 10, 15, and 20%, respectively). Samples were identified as M_0, M_1, M_2, M_3, and M_4.

The shelled eggs had an average weight of 50 g, about 33 g of egg white and about 17 g of yolk each.

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Five samples of egg noodles with durum wheat semolina and different quantities of yolks and whites also were prepared to simulate commercially available products (Table I). Samples were identified as X_1, X_2, X_3, X_4, and X_5.

The five analytic procedures used were:

1. Weight determination of total sterol fraction precipitated with digitonin (14,15).

2. Determination by vapor phase chromatography (VPC) of single sterols and their interrelationships. The digitonin derivatives, obtained according to the method of Muntoni and co-workers (6) were converted to the trimethylsilyl derivatives for VPC analysis by dissolving in 1 ml of anhydrous pyridine and adding 0.6 ml of hexamethyldisilazane and 0.2 ml of trimethylchlorosilane. The mixture was shaken for 30 min at 50° C and centrifuged; the supernatant was used for VPC analysis.

VPC was done using a Varian Aerograph 1200 gas chromatograph with a flame ionization detector and a column-glass column (2 m long, 3 mm ID) packed with a 1.5% OV-17 on 60–80 mesh Chromosorb W/AW and conditioned overnight at 20° C above maximum operating temperature. The flow rates in milliliters per minute were carrier (N_2), 30; hydrogen, 30; and air, 300. The Centigrade temperatures were injector, 300; detector, 300; and column oven, 260. Results are detailed in Table II.

3. VPC determination of the fatty acids and the relationships between some of them. In this analysis, 4-g samples of finely ground noodle were placed in a 250-ml separator with 20 ml of acetone. After the mixture was shaken for approximately 15 min, the supernatant was filtered through a 1-cm layer of anhydrous Na_2SO_4 and placed in a funnel with a medium porosity fritted glass disk. The solvent was evaporated under nitrogen flow; the residue was transesterified (16) and analyzed by VPC. This VPC was done using a Varian Aerograph 1200 gas chromatograph with a flame ionization detector and a column-inox-steel column (2 m long, 3.18 mm ID) packed with 10% LAC 3-R-728 on 60–70 mesh Chromosorb W/AW. The flow rates in milliliters per minute were carrier (N_2), 25; hydrogen, 25; and air, 300. The Centigrade temperatures were injector, 230; detector, 230; and column oven, 195. Results are detailed in Table III.

4. Electrophoretic analysis with subsequent densitometric evaluation of the patterns regarding the fraction of protein extracted with 0.15*N* NaCl solution (1).

TABLE I
Composition of Samples Simulating Commercial Products Made From Semolina

Sample	Egg Yolks		Egg Whites	
	No./kg of Noodles	Average Percent	No./kg of Noodles	Average Percent
X_1	7	12	4.5	15
X_2	5.3	9	4.5	15
X_3	4.1	7	3.0	10
X_4	4.1	7	2.4	8
X_5	3.5	6	2.4	8

TABLE II
Sterols (Percent of Weight[a]) of Fats From Noodles and Their Interrelationships

Sample	Cholesterol (%)	Campesterol (%)	β-Sitosterol (%)	Cholesterol/ Campesterol (%)	Cholesterol/ β-Sitosterol (%)	β-Sitosterol/ Campesterol (%)
S_0	...	28.27	71.74	...	...	2.54
S_1	31.40	19.62	49.07	1.60	0.64	2.50
S_2	48.47	14.72	36.81	3.29	1.32	2.50
S_3	57.39	11.93	30.68	4.81	1.87	2.57
S_4	66.85	9.77	24.39	6.75	2.70	2.50
F_0	...	19.51	80.49	...	...	4.13
F_1	33.78	13.51	52.70	2.50	0.64	3.90
F_2	48.78	10.37	40.85	4.70	1.19	3.94
F_3	61.29	8.07	30.65	7.60	2.00	3.80
F_4	68.00	6.66	25.33	10.19	2.70	3.80
M_0	...	25.85	74.14	...	...	2.87
M_1	33.03	17.72	49.25	1.87	0.68	2.80
M_2	48.95	13.29	37.78	3.68	1.30	2.84
M_3	57.58	11.11	31.31	5.18	1.84	2.82
M_4	66.29	9.09	25.62	7.18	2.55	2.82
X_1	75.91	6.27	17.82	12.11	4.27	2.84
X_2	73.38	7.14	19.48	10.28	3.77	2.73
X_3	65.75	9.59	24.66	6.87	2.66	2.57
X_4	67.01	8.25	24.74	8.12	2.71	3.00
X_5	65.48	9.52	25.00	6.88	2.72	2.73

[a]All values are average of two determinations.

5. Immunodiffusion analysis of protein extracted with 0.15*N* NaCl solution (3).

The data obtained using these five procedures on the noodle samples of sets S, F, and M were used in constructing the calibration graphs for determining the number (or percentage) of yolks or whites in the noodles of set X.

RESULTS AND DISCUSSION

Procedures 1–3 determine only the percentage of egg yolk in the noodle. The two classes of substances—sterols and fatty acids—that can be determined by these procedures are found only in milled products and in egg yolks and are not present in egg whites (17).

Moreover, procedures 4 (electrophoretic) and 5 (immunologic) provide information only on the egg white content of the noodle, because both require the determination of some proteic components (mainly conalbumin) that are contained exclusively in egg white.

Results obtained on the samples of set X (Table IV) demonstrate that the experimental procedures provide information only about percentage or number of yolks or whites in the samples.

TABLE III
Fatty Acids (Percent of Weight[a]) of Fats From Noodles and Values of Percentage of Oleic Acid/Linoleic Acid Ratio

Sample	Palmitic (%)	Palmitoleic (%)	Stearic (%)	Oleic (%)	Linoleic (%)	Linolenic (%)	Oleic/ Linoleic (%)
S_0	19.01	1.14	1.60	21.34	54.02	2.54	0.395
S_1	18.78	1.62	3.03	28.72	44.88	2.57	0.640
S_2	20.02	2.11	4.11	32.44	38.87	2.03	0.835
S_3	20.99	2.87	4.81	35.55	33.27	2.06	1.068
S_4	21.13	3.26	4.32	38.21	31.23	1.41	1.223
F_0	17.06	0.67	1.14	16.15	61.09	3.63	0.264
F_1	20.26	1.94	2.76	25.34	46.80	2.52	0.541
F_2	20.07	2.64	3.89	32.91	38.18	1.89	0.862
F_3	22.84	2.97	4.66	34.57	32.45	1.97	1.065
F_4	21.74	3.70	3.94	38.41	30.15	1.57	1.274
M_0	18.88	0.48	1.69	17.77	57.87	2.93	0.307
M_1	20.17	1.82	2.90	25.32	46.76	2.46	0.541
M_2	21.51	2.76	3.46	31.24	38.61	1.96	0.809
M_3	20.44	2.91	3.64	36.33	34.44	1.79	1.055
M_4	19.15	3.55	3.85	39.51	31.90	1.67	1.239
X_1	23.57	2.49	7.01	37.77	27.42	1.17	1.377
X_2	22.32	2.87	6.41	37.26	29.33	1.40	1.275
X_3	24.14	2.94	5.17	35.39	30.28	1.47	1.169
X_4	22.48	2.97	6.08	33.76	33.04	1.16	1.022
X_5	25.37	2.77	4.74	34.04	30.92	1.52	1.101

[a]All values are average of two determinations.

To obtain precise information about the composition of commercial products (sometimes prepared using different numbers of yolks and whites), at least two of the experimental procedures must be used—one that gives information about the percentage or number of yolks and one about the percentage or number of whites.

When a procedure based on determination of a yolk constituent is used, the composition of the matrix also must be considered. Figures 1 and 2 show that the type of milled product used in preparing noodles greatly influenced the values obtained in procedures 2 and 3. These procedures allow determination of components that also are contained in the milled product, the quantities of which depend on the percent of durum wheat and soft wheat products.

The results of procedures 2 and 3 should be clarified further, ie, these concern determining the ratios of the percentages of cholesterol to campesterol, cholesterol to β-sitosterol, and oleic acid to linoleic acid. The first relationship appears to be particularly influenced by the composition of the matrix, since the campesterol content is higher in the durum wheat semolinas than in the soft wheat flours as shown by the sterol contents for samples S_0, F_0, and M_0 (Table II).

TABLE IV
Data From Experimental Procedures Applied to Sample Set X[a]

			VPC of TMS[b] Derivatives of Sterols				VPC of Fatty Acids	
			% Cholesterol/% Campesterol		% Cholesterol/% β-sitosterol		% Oleic acid/% Linoleic acid	
	Total Weight	Sterols, Recovery (%)	No. of Yolks/kg of Noodles	Recovery (%)	No. of Yolks/kg of Noodles	Recovery (%)	No. of Yolks/kg of Noodles	Recovery (%)
X_1	6.8	97	7.3[c]	104.3	7.1	101.4	6.9[d]	98.6
X_2	5.3	100	5.3	100	5.7	107.5	5.7	107.5
X_3	4.4	107.3	4.1	100	4.1	100	4.3	104.9
X_4	4.1	100	4.3	104.9	4.2	102.4	4.1	100
X_5	3.6	102.9	3.3	94.3	3.9	111.4	3.8	108.6

	Electrophoretic Analysis		Immunodiffusion Analysis	
	No. of Whites/kg of Noodle	Recovery (%)	No. of Whites/kg of Noodle	Recovery (%)
X_1	4.6	102.2	4.2	93.3
X_2	4.6	102.2	4.4	97.8
X_3	2.8	93.3	3.0	100
X_4	2.2	91.7	2.6	108.3
X_5	2.5	104.2	2.4	100

[a]Values are average of two determinations. Percent recoveries refer to data in Table I
[b]VPC of TMS = Vapor phase chromatography of trimethylchlorosilane.
[c]Values calculated on calibration curve S (see text and Fig. 1).
[d]Average values of data interpolated on calibrations curves S, M, and F (see text and Fig. 2).

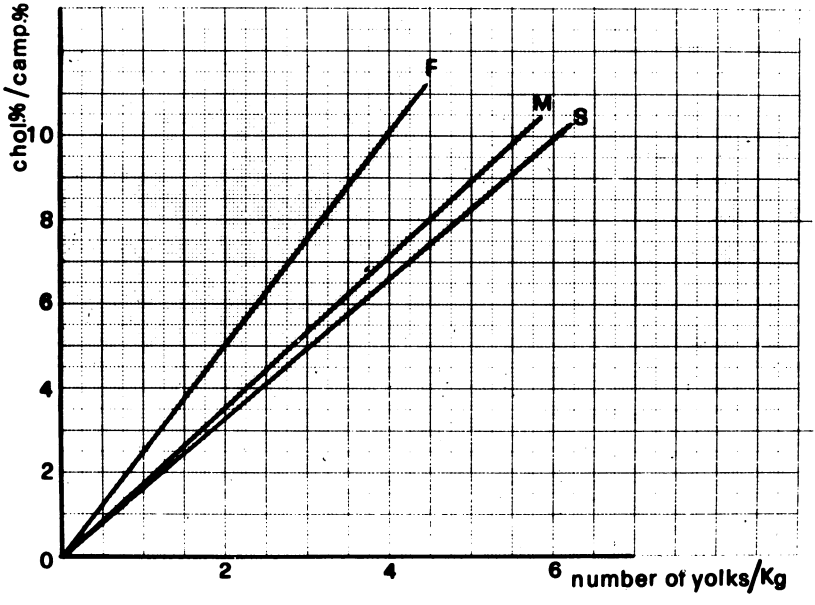

Fig. 1. Calibration curves (percentage of cholesterol/campesterol versus number of yolks per kilogram of noodles) of samples of sets F, M, and S.

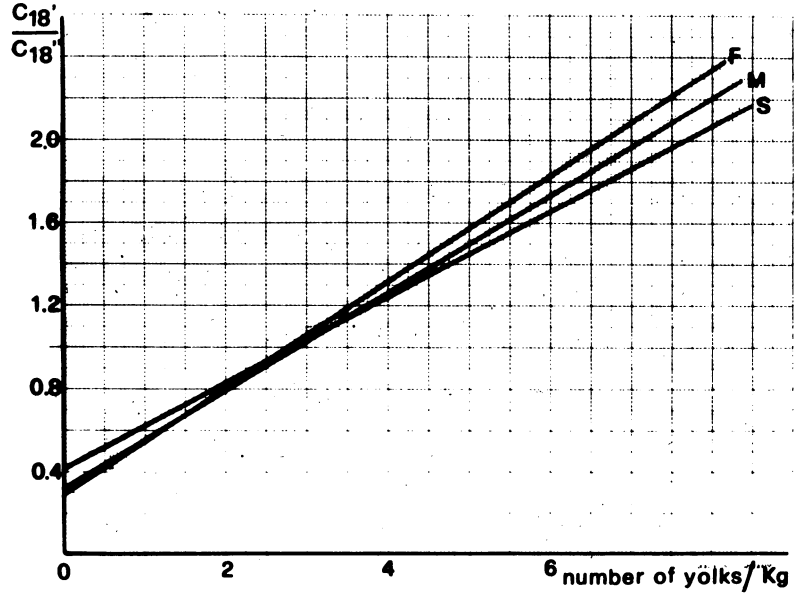

Fig. 2. Calibration curves (percentage of oleic acid/linoleic acid versus number of yolks per kilogram of noodles) of samples of sets F, M, and S.

Figure 1 shows the curves obtained through linear regression of the ratios of the percentages of cholesterol to campesterol versus the number of yolks per kilogram of noodles. The curves have three different slope values for the three different matrix compositions; thus, the same ratio of percentages of cholesterol to campesterol, interpolated on these three curves, leads to three different yolk numbers. Consequently, the type of milled product in the noodle must be known before choosing a calibration curve to determine yolk number. This information is supplied by immunologic (18) and electrophoretic (19) methods, but it may be useful to consider the ratio of percentages of β-sitosterol to campesterol, which appears to vary with the flour content of the matrix as seen in Fig. 3.

The second ratio, the percentages of cholesterol to β-sitosterol, is not influenced by the type of milled product in the noodles, because the β-sitosterol contents are similar in durum and soft wheat products.

The ratio of the percentages of oleic acid to linoleic acid, like that of cholesterol to campesterol, is influenced—although differently—by the composition of the matrix. The percentage of two fatty acids differ in durum and soft wheat products: The percentage of oleic acid is greater in durum wheat semolina than in soft wheat flour; the percentage of linoleic acid is greater in soft wheat flour than in durum wheat semolina. Thus, the ratio of these fatty acids is greater for the semolina than for the soft wheat flour as shown by samples S_0 and F_0 (Table III); this ratio for the mixture of these two wheat products (M_0) has a value between those of S_0 and F_0.

Addition of increasing quantities of egg yolk to the milled products modifies the percentage of oleic and linoleic acids, so that the ratio reaches close values

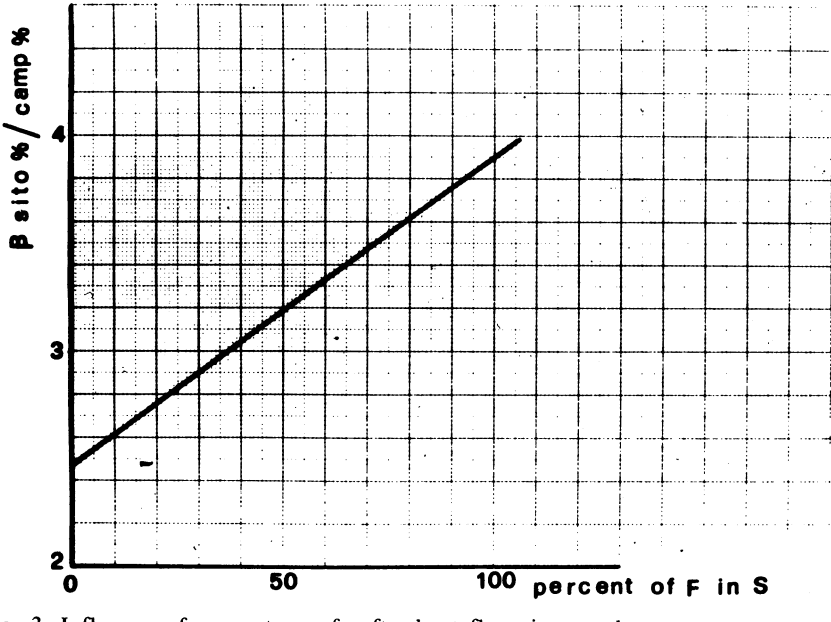

Fig. 3. Influence of percentage of soft wheat flour in sample over percentage of β-sitosterol/campesterol.

when the number of yolks is near three per kilogram of noodles; that occurs for any composition of the matrix.

When the number of egg yolks in the noodles exceeds three, the ratio again assumes different values, but the results are higher for noodles prepared with soft wheat flour than for those prepared with durum wheat semolina. Figure 2 shows the curves for the ratios of percentages of oleic to linoleic acids for samples containing up to more than four yolks per kilogram of noodles. The curves are obtained from the following equations, derived through linear regression:

$$\text{set S} \quad y = 0.415 + 0.209 \cdot x$$
$$\text{set F} \quad y = 0.292 + 0.254 \cdot x$$
$$\text{set M} \quad y = 0.315 + 0.237 \cdot x$$

The correlation coefficients (r) for the three curves had the following values: S, 0.9975; F, 0.9954; and M, 0.9982.

Procedures 1, 2, and 3 can be used for evaluating the percentage of yolks, and procedures 4 and 5 for evaluating the percentage of whites in noodles. Consumers want to know the number of whole eggs, however, and to provide this information, the yolk and white numbers per kilogram of noodles must be considered instead of the percentage of yolk and white. If these numbers nearly coincide, they also represent the number of whole eggs; otherwise, only distinct analytic data for the number of yolks or whites can be given.

The percentage of single fatty acids, like that of single sterols, can differ in various stocks of durum wheat semolina (and soft wheat flour). This occurrence obviously restricts the reliability of procedures 1–3 compared with the more specific electrophoretic and immunologic methods; these are based on the evaluation of protein components that are present at uniform levels in egg whites.

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