

# Portuguese Market of Food Grade Salt

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## ABSTRACT

*Statistical data are presented to show the food grade salt market evolution and to emphasize the purified salt consumption increase compared to crude salt.*

*The sales of crude and purified salt are examined. Then, the raw materials required by the purifying plants, and their sales, between 1970 and 1980, are focused upon.*

*To verify the type of marketing evolution over several years, the*

*real values are compared with the forecasts gathered from a calculated regression straight line. The market perspectives up to 1985 are also shown.*

*The distribution of purified salt food uses during the last few years, is analyzed more closely. The limits of human salt intake are estimated in a proposed model, being on the order of 4 kg/inhab. year.*

## MAIN TYPES OF FOOD GRADE SALT

The salt market situation in Portugal, using as illustration the year 1980 is shown in Figure 1.

### Crude Salt

The marine salt production in Portugal over the centuries has been mostly for food use but has had its periods of boom and bust. By 1920, the production presented favorable characteristics, with annual exports reaching about 100,000 tonnes. However, about then some difficulties began to arise, due mainly to the fact that the vessels which used salt as a ballast stopped sailing.

Nevertheless, in spite of mechanization and recent technological evolution about 32 modernized saltworks produce 50% of the total national output. Based either on production centers or on national production, sound statistical data only became available from 1952 (Table 1). As to solar salt and rock salt consumer sectors, i.e., as regards food grade salt, the existing information dates from 1957 (Table 2).

Because rock salt, without any type of treatment, has had no significant food application, its importance is diminishing. National consumption, other than the above and relative to the same years, is given in Table 3. Analyzing Tables 2 and 3, we note that the food sector has been a good user of crude salt but today has yielded its top position to the chemical industry. We call attention to the fact

that crude, or raw salt is that salt which has not undergone, after harvesting, any kind of treatment.

### Treated Salt

**Purified or Hygienized Salt.** Owing to the necessity of assuring the supply to consumers of a product in the best hygienic conditions, a new type of salt was introduced in the market, as a test in 1964, and from 1967 on was offered as a regular product under the name of purified or hygienized salt. Practically, it is solar salt, duly washed in saturated brines, and, generally centrifuged, thermically dried, then milled, cribbled and sold in sealed packages.

To be labelled as hygienized salt, it must comply with the following physico-chemical standards:

- insoluble in water . . . 0.2% maximum (in dry product)
- total chlorides expressed as sodium chloride . . . 98% minimum (in dry product)
- loss of mass (at 110–115°C during two hours) . . . 1% maximum.

As may be seen from Table 4, the sales of hygienized salt have been increasing in importance. Where there was just one salt treating unit, in 1964, now inactive, and working then with a different technique, there are now seven plants, two of them producing more than 50% of the national production.

**Other Types of Treated Salt.** About the same time, other

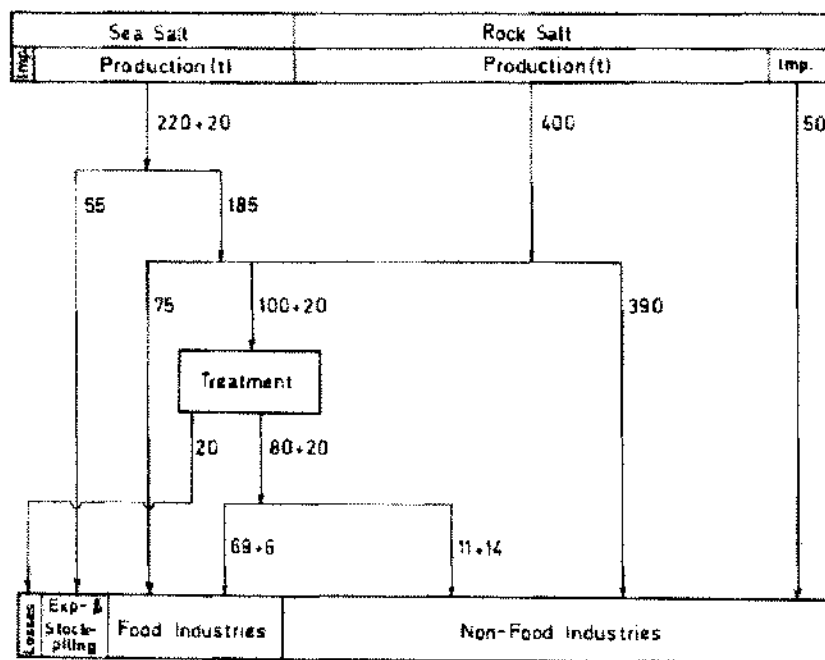


Figure 1. Salt market situation in 1980.

TABLE I  
Salt Production (solar and rock salt)  
(t)

Years	Solar salt	Rock salt	Total
1952	182 407	544	182 951
1953	282 651	698	283 349
1954	303 070	718	303 788
1955	300 195	700	300 895
1956	136 229	350	136 579
1957	326 693	28 823	355 516
1958	334 389	59 872	394 261
1959	227 698	62 728	290 426
1960	219 356	70 644	290 000
1961	285 386	73 440	358 826
1962	330 492	74 472	404 964
1963	280 220	79 621	359 841
1964	238 698	89 740	328 438
1965	424 383	90 445	514 828
1966	256 914	101 368	358 282
1967	353 254	116 725	469 979
1968	272 758	152 051	424 809
1969	143 854	166 709	310 563
1970	226 241	195 685	421 926
1971	177 353	236 365	413 718
1972	232 616	276 359	508 975
1973	229 945	303 058	533 003
1974	233 574	311 114	544 688
1975	225 973	297 433	523 406
1976	172 430	307 277	479 707
1977	166 022	346 136	512 158
1978	152 494	322 871	475 365
1979	169 888	407 807	577 695
1980	217 560	399 860	617 420

kinds of treated salts were developed, namely, refined, table and iodized salts.

The first two are obtained by recrystallization in vacuum evaporators from rock salt solutions, followed by centrifugation, drying and packing. Iodized salt is produced by adding potassium iodide, duly stabilized, to purified salt.

Because the first two are intended for a more restricted and exigent sector, the corresponding specifications must obviously be more accurate and conform to the respective following specifications:

	Refined Salt	Table Salt
Halogens, expressed in $\text{Cl}^-$	59.7% (min.)	60.0% (min.)
Insolubles	0.05% (max.)	0.03% (max.)
Calcium, expressed in $\text{Ca}^{++}$	0.08% (")	0.04% (")
Magnesium, expressed in $\text{Mg}^{++}$	0.06% (")	0.05% (")
Sulphates, expressed in $\text{SO}_4$	0.30% (")	0.20% (")
Moisture	0.20% (")	0.20% (")

Both refined and table salt have been consumed by the alimentary sector, though about 90% of the refined salt is also used by the textile industry in the North. As for iodized salt, it is intended exclusively for the prophylaxis of endemic goiter, in a known zone of Portugal, and sales are carried out on a domestic consumption and salting food basis at an agro-pecuary level.

The relative proportion of the overall food grade market of these three types of treated salt represented today is about 10% of the hygienized salt sales volume.

TABLE 2  
Raw Food Grade Salt Consumptions  
(t)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Cattle feeding	22	39	84	46	19	37	124	241	453	494	402	293	437
Codfishing fleet	52 377	57 417	51 043	54 197	59 542	59 150	68 868	65 183	59 163	50 904	59 402	63 595	56 868
Meat canning	2 201	2 449	1 495	1 351	1 595	1 866	1 555	1 115	494	385	308	648	908
Fish canning	24 980	30 062	17 729	25 852	28 246	29 013	23 453	28 368	29 921	26 382	26 153	16 639	14 844
Vegetables canning	2 528	1 526	1 625	2 400	2 603	2 896	2 921	7 459	7 326	6 717	6 484	7 422	6 721
Food flour	326	313	262	319	110	140	255	49	58	83	82	193	149
Icecreams	—	—	—	—	—	—	—	2	4	—	—	—	—
Dairy	732	1 045	938	1 486	1 580	1 675	1 733	4 452	4 383	4 111	3 653	3 884	3 380
Bakery	5 708	6 960	6 389	7 264	8 749	9 361	9 042	18 577	17 629	16 543	15 223	16 390	14 565
Olive oil refinery	99	167	122	279	46	115	88	33	8	26	92	34	42
Meat salting	9 872	12 529	9 676	13 594	14 444	16 060	16 034	46 883	46 918	44 834	41 200	43 956	39 064
Fish salting	23 746	29 504	24 464	27 354	24 181	26 421	27 582	53 154	51 622	50 684	45 715	43 990	39 203

TABLE 2 (cont.)  
Raw Food Grade Salt Consumptions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Cattle feeding	298	777	557	728	844	804	2 102	1 890	1 886	2 553	3 389
Codfishing fleet	53 874	50 193	38 440	38 792	34 648	29 840	20 355	15 208	23 736	20 691	19 495
Meat canning	971	1 014	749	761	350	738	683	533	3 674	767	121
Fish canning	16 913	11 863	13 823	16 276	10 435	6 457	4 300	8 436	9 936	7 076	5 326
Vegetables canning	6 678	6 026	5 349	5 431	4 732	4 771	3 860	4 562	3 803	3 482	2 723
Food flour	166	28	137	257	45	10	—	—	45	381	235
Icecreams	—	—	—	—	—	—	—	—	—	—	—
Dairy	3 289	2 992	2 642	2 776	2 472	2 464	2 133	2 952	2 474	2 347	1 817
Bakery	14 358	13 062	11 467	11 620	10 570	10 499	8 685	11 588	8 815	8 636	6 894
Olive oil refinery	259	203	297	260	350	38	—	31	24	10	—
Meat salting	38 943	34 718	30 536	30 882	27 967	27 966	23 032	30 564	23 734	22 730	18 184
Fish salting	39 804	34 899	29 844	29 295	26 008	25 701	21 279	29 695	22 041	20 726	16 935
Tripe industry	680	789	735	502	439	593	699	648	597	374	298

### COMPARISON BETWEEN CRUDE AND HYGIENIZED SALT CONSUMPTION

From the simple comparison of the totals of crude salt sales, as shown in Tables 2 and 3, and those of hygienized salt, indicated in Table 4, an increase is noted in the latter. Considering only the food sector (Table 2), we see that today the consumption of hygienized salt (Table 4) has almost reached the level of crude salt use.

#### The Hygienized Salt Sector

**Total Sales of Hygienized Salt.** In this analysis, carried out from 1970 to 1980, total sales are considered independent of its actual destination (food sector or not).

Keeping in mind the known hygienized salt sales during that period of time, and adapting by the square minima method a straight line to the sales of six consecutive years, we verify that the actual values differ from the forecast

ones, from the straight line in a maximum of 4 000 t/year, or 12% deviation. Thus, taking as a basis annual sales from 1975 to 1980, the relative values for the years 1981 to 1985 are given through the equation:

$$\text{Annual sales} = 83\,000 + 5\,600(\text{year}-1980).$$

So, in the last six years there has been a medium annual rise of about 6 000 t/year.

**Raw Material Purchases.** Hygienized salt has become the main use for crude solar salt after conversion to processed salt. Because the production of solar salt is greatly dependent on climatic conditions, we also analyzed the consumption of raw materials from 1970. Their growth is shown in Table 5.

Proceeding to an analysis similar to the one above, the following relationship is found:

$$\text{Raw material purchase} = K \times \text{annual sales}.$$

TABLE 3  
Consumption of Non-Edible Raw Salt  
(t)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Starches	—	—	—	—	293	210	236	243	301	238	272	227	—
Pottery	7	12	13	36	—	—	1	—	99	—	—	—	14
Cements	—	—	—	—	7	7	16	30	40	8	26	9	8
Water													
softening	1 733	1 816	1 144	2 571	2 454	2 938	3 057	12 487	12 899	12 211	11 317	11 683	10 431
Tanning	2 365	2 568	2 647	3 866	2 494	3 053	3 144	8 751	8 793	8 258	7 072	7 786	6 180
Explosives	4	5	7	6	21	12	12	18	10	11	58	27	10
Woolen													
manufacturer	—	—	—	—	—	1 599	110	8	158	70	—	—	—
Files	25	—	—	—	—	—	17	—	—	15	8	—	—
Metals	—	—	—	—	—	—	9	—	—	—	—	—	—
Paper	—	—	—	—	—	—	—	—	—	96	93	64	9
Fertilizer	—	—	2	—	—	—	—	—	—	—	—	—	58
Chemical													
industry	34 914	73 635	81 806	108 960	101 258	111 080	121 366	128 535	133 207	160 995	162 202	189 802	217 520
Oil refinery	—	—	—	—	—	—	—	—	—	—	72	—	50
Refrigeration	104	80	160	223	165	200	154	168	150	150	102	95	150
Rosins	714	358	472	479	768	299	269	204	200	64	65	60	61
Soaps	10	1 243	764	652	624	59	580	595	610	504	391	38	335
Textiles	3 845	2 645	2 711	2 618	1 920	1 584	1 555	1 840	1 363	1 507	1 426	1 390	1 369
Glass industry	—	—	37	—	—	—	—	12	—	6	—	—	—
Sundry	121 077	116 866	120 204	7 682	1 571	2 154	2 560	3 445	2 786	1 515	209	2 196	3 181

TABLE 3 (cont.)  
Consumption of Non-Edible Raw Salt  
(t)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Pottery	11	4	—	—	—	21	—	—	—	—	—
Cements	—	24	3	—	45	9	—	—	62	—	—
Water											
softening	10 695	10 407	8 492	8 350	8 027	8 493	7 874	9 752	8 530	8 337	5 533
Tanning	6 024	5 976	5 535	6 505	5 785	4 813	3 955	5 239	6 400	5 509	5 374
Explosives	9	8	3	6	5	3	3	3	2	3	—
Files	—	39	—	15	—	—	—	—	—	—	—
Paper	—	—	—	—	—	—	—	—	—	13	—
Fertilizers	—	15	—	—	60	2	—	—	—	—	—
Chemical											
industry	226 730	268 175	299 232	292 596	339 714	348 023	341 721	359 782	332 190	394 014	418 065
Oil refinery	47	30	50	—	16	67	—	—	—	—	—
Refrigeration	162	170	115	21	35	55	39	24	77	19	24
Rosins	55	79	78	39	67	49	27	9	7	20	5
Soaps	384	591	180	398	393	339	418	386	363	357	458
Textiles	1 146	966	736	789	1 021	989	1 001	976	1 102	2 593	3 763
Sundry	2 569	2 312	3 193	2 935	4 352	4 109	5 855	3 156	8 112	4 637	4 758

This constant was obtained by the square minima method, being:

$$K = 1.26.$$

So, the forecast of raw material consumption for the years 1981 to 1985, was obtained from the sales forecast by multiplying these by the referred coefficient. The absolute er-

ror for these forecasts is estimated at 9 000 t and the relative error 19%.

As for the coefficient, it may be said that in the last eleven years there has been a loss in relation to raw material purchase of 26%.

**Main Consuming Sectors.** The food sector has been from the very start of salt industrial processing the main

TABLE 4  
Purified Salt Sales

Years	Tonnes
1970	32 410
1971	42 073
1972	46 974
1973	50 338
1974	53 337
1975	54 674
1976	58 984
1977	66 978
1978	73 254
1979	77 925
1980	81 343

TABLE 5  
Raw Material Purchases for Hygienizing Units

Years	Tonnes
1970	53 717
1971	47 375
1972	58 545
1973	65 920
1974	65 799
1975	60 511
1976	73 973
1977	85 274
1978	95 011
1979	98 115
1980	99 731

consumer. Yet, of late there has been a demand from other markets. Business records show that the hygienizing consuming sectors are distributed as follows:

- domestic consumption
- bakery
- meat and tripes products
- animal feed
- water treatment (water softening).

From the indicated items, the first three are obviously included in the human alimentary area. We draw attention to the fact that salt utilization for cattle feed and water softening is very recent.

Table 6 gives the registered sales of recent years in each of the several food consumer sectors, and the total.

#### Total National Consumption of Food Grade Salt

The total consumption of food grade salt by types and principal consuming sectors, from 1970 to 1980, is shown in Table 7. Food grade raw salt consumption dropped, and it was verified that from 1970 to 1975, 829,043 t were consumed, while from 1976 to 1980 only 446,709 t were sold. That change represents 54% of the original amount.

TABLE 6  
Consumption of Hygienized Salt for Food Purposes

Years	Domestic consumption (t)	Bakery (t)	Meat tripes (t)	Totals (t)
1976	45 163	3 405	2 805	51 373
1977	51 087	3 903	3 386	58 376
1978	57 439	4 268	3 500	65 207
1979	56 562	4 143	3 914	64 619
1980	60 181	4 254	3 965	68 400
% of totals:	87.5-88.1	6.2-6.7	5.4-6.1	86.8-87.6

The chief consuming sectors responsible for this trend were fish and meat salting, meat and fish canning, the cod fishing fleet, as well as bakery use.

Indeed, while the fisheries have been sensibly diminishing their catches, on the other hand there has been an increase of freezing preservation.

As for bakery, it has developed a marked preference for treated salt, more strictly, for purified flour salt, this accompanied by a lesser consumption as well.

The other sectors have also shown a similar tendency for a lesser consumption, as they all prefer treated salts.

As for these last qualities, an increased trend is noticed both for the purified type, of wider utilization, and the three types of refined, table and iodized salts.

Thus, 250,190 t of purified salt was sold from 1970 to 1975, while from 1976 to 1980 the amount reached was 307,975 t, corresponding to an increase of about 23%. This last tonnage is, more or less, 70% of the total food consumption of raw salt, 40% of the global consumption of the food grade raw and purified salt, and 40% of the total consumption of food grade raw and treated salt in the same period.

Sales of refined, table and iodized salt for food purposes, in the same periods, have shown levels of 19,762 t and 29,271 t, which means an increase of 48%.

#### Per Capita Consumption

The upper limits of the intake per capita are obtained by dividing the total annual consumption of food grade salt by the resident population.

In fact, there is no correlation between the resident population and the corresponding year, as in the same way there is no linear relation between the total consumption of salt and the year to which that consumption refers. Likewise, the total amount of consumed shows to be linearly independent of the resident population.

Table 8 shows salt consumption divided into two parts, one for a consumption to which we may attribute an intake of 100% (bakery, dairy, refined and table salt) and the other part with an intake less than 100%.

TABLE 7  
Food Grade Salt Consumptions  
(t)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
<i>Raw salt</i>											
Mean canning	971	1 014	749	761	350	738	683	533	3 674	767	121
Fish canning	16 913	11 863	13 823	16 276	10 435	6 457	4 300	8 436	9 936	7 076	5 326
Vegetable canning	6 678	6 026	5 349	5 431	4 732	4 771	3 860	4 562	3 803	3 482	2 723
Codfishing fleet	53 874	50 193	38 440	38 792	34 648	29 840	20 355	15 208	23 736	20 691	19 495
Dairy	3 289	2 992	2 642	2 776	2 472	2 464	2 133	2 952	2 474	2 347	1 817
Bakery	14 358	13 062	11 467	11 620	10 570	10 499	8 685	11 588	8 815	8 636	6 894
Olive oil refinery	259	203	297	260	350	38	—	31	24	10	—
Meat salting	38 943	34 718	30 536	30 882	27 967	27 966	23 032	30 564	23 734	22 730	18 184
Fish salting	39 804	34 899	29 844	29 295	26 008	25 701	21 279	29 695	22 041	20 726	16 935
Tripe industry	680	789	735	502	439	593	699	648	597	374	298
Total	175 769	155 759	133 882	136 595	117 971	109 067	85 026	104 217	98 834	86 839	71 793
<i>Purified salt</i>											
Domestic consumption	26 016	34 008	37 284	40 361	42 208	42 337	45 163	51 087	57 439	56 562	60 181
Bakery	2 021	2 419	2 400	2 745	2 979	3 232	3 405	3 903	4 268	4 143	4 254
Meat and tripe	1 389	1 690	1 836	2 166	2 387	2 712	2 805	3 386	3 500	3 914	3 965
Total	29 426	38 117	41 520	45 272	47 574	48 281	51 373	58 376	65 207	64 619	68 400
<i>Refined, table and iodized salt</i>	1 658	2 118	3 234	3 969	4 136	4 647	4 922	5 499	6 572	5 908	6 370
Global total	206 853	195 994	178 636	185 836	169 681	161 995	141 321	168 092	170 613	157 366	146 563
Resident population	9 700 000	8 870 000	8 524 000	8 564 000	8 782 000	9 449 000	9 699 000	9 773 000	9 820 000	9 325 000	9 395 000
Total consumption per capita	21.30	22.10	20.96	21.70	19.30	17.10	14.60	17.20	17.40	16.90	15.60

TABLE 8

Salt Intake

Year	Consumption with 100% intake (t) (XI)	Consumption with less than 100% intake (t) (YI)	Per capita intake (kg year <sup>-1</sup> inhab. <sup>-1</sup> ) (CI)
1970	21 326	185 527	4.0
1971	20 591	175 403	4.2
1972	19 191	159 445	4.0
1973	20 318	165 518	4.2
1974	19 724	149 957	3.9
1975	20 242	141 753	3.6
1976	18 345	122 976	3.1
1977	23 142	144 950	3.8
1978	21 229	149 384	3.6
1979	20 114	137 252	3.6
1980	18 535	128 028	3.3

We note that the first type (2nd column) shows a relative steadiness and corresponds to the annual consumption of 2.19 kg/inhab. year.

The values for other consumption have decreased with time and can be approximated by a straight line.

Remaining consumption = 175,000 - 4,900 (year-1970), which is a straight line showing an absolute error of a maximum of 24,000 t/year and a relative maximum error of 20%.

So, verifying that the upper limit of per capita intake has been dropping annually, we may attribute this decrease to the reduction of consumption with less than 100% intake (i.e., in fish salting and the cod fishing fleet).

We may also attempt to determine which fraction of this salt corresponds to the intake.

Taking  $f$  as the ingested salt fraction, the per capita intake will be given by:

$$C_i = \frac{X_i + f Y_i}{P_i}$$

and the mean per capita intake for the 11 years period is given by:

$$\bar{C} = A + fB$$

where

$$A = \frac{1}{11} \sum \frac{X_i}{P_i}$$

$$B = \frac{1}{11} \sum \frac{Y_i}{P_i}$$

The annual deviation from the mean is given by

$$e_i = C_i - \bar{C}$$

The sum of the squares of these deviations has minimum value when

$$f = \frac{\sum \frac{X_i Y_i}{P_i} - 11 \times A \times B}{11B^2 - \sum \left( \frac{Y_i}{P_i} \right)^2}$$

It may be verified, from the exact data in Table 8 that

$$A = 2.2 \text{ kg/inhab. year}$$

$$B = 16.4 \text{ kg/inhab. year}$$

$$f = .095$$

and

$$\bar{C} = 3.74 \text{ kg/inhab. year.}$$

It may be verified that the mean salt intake per capita is  $(3.7 \pm .2) \text{ kg/year inhab.}$  for a confidence interval of 90%.

### European Consumption of Packed Food Grade Salt

The general indicator utilized to estimate salt consumption was also the sale of food grade salt, regardless of the consuming sector. There has been an ever increasing demand for pre-packed salt because of its hygienic appearance. The care in the display of this product to the public has had an echo at FAO. During the study in collaboration with WHO to establish a norm for food grade salt, it was proposed that "the storage, conditioning and transport" be done in hygienic conditions. This, is likewise noted in Portugal, as shown in Table 7; treated salt consumption (i.e., compulsory pre-packing before sale to the public) has already passed that for raw salt.

In this context, the main consumer markets for treated

salts, including purified and hygienized salt, may be compared to the available data relative to the eleven salt producer countries of West Europe.

Therefore, there are in this economic space, two principal big areas of consumption. The first includes mainly the following sectors:

- Bakery;
- Food preserving (vegetables, meat, fish, etc.);
- Meat preserving;
- Dairy;
- Pre-cooked dishes, soups;
- Appetizers.

The second includes mainly:

- Food preparation (cooking salt, table salt and domestic salting);
- Non-alimentary (non-edible applications) (water softening, deicing, salt bathing, weedkilling, cleaning).

Thus, the situation in Portugal shows some differences, these being mainly at the level of domestic deicing, salt bathing, weedkilling and cleaning. These uses, primarily chiefly the first one, are practically unknown in Portugal because of the climate. Even so, water softening shows a parallel development.

### CONCLUSIONS

Annual sales of hygienized salt, have been increasing at a rate of 6 000 t per year, which corresponds to an annual growth of raw material consumption of about 8 000 t, considering the losses that occur during the process.

The consumption of raw salt shows a decreasing trend. Regarding the overall intake, it may be said that the ingestion of salt may be divided into two fractions—one of 2.2 kg/inhab. year, relative to the bakery, dairy, refined salt and table salt sectors, and the other of 1.5 kg/inhab. year, corresponding to 9.5% of the remaining consumption of food grade salt to which there may correspond an intake variable from type to type but always less than 100%.

So, if the annual salt intake stays about 4 kg/inhab. year (i.e., 11 g/inhab. day).

That consumption is rather high per inhabitant, as per the last row of Table 7, as it was shown subsequently, the corresponding intakes are considerably lower but similar to the developed countries' intake (5 to 7 kg/inhab. year).