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# Current Status of Nickel Contamination of Local Vegetable Ghee

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Nickel contamination of locally produced vegetable ghee has been evaluated using the atomic absorption flame photometric method, employing n-hexane as solubilization medium. The data, based on 3 batches of samples comprising a total of 32 samples procured from 18 manufactures, is reported as $\bar{X}\pm SD$, for 3 to 5 replicates. The nickel concentration ranges for the three batches are, 0.445-0.726 mg 100 $g^{-1}$, 0.668-1.2668 mg 100 $g^{-1}$, and 0.395-1.234 mg 100 $g^{-1}$, thereby indicating an inefficient nickel filtration process at individual industrial units. Substantial comparative variations in the nickel concentration are observed in the output of a given ghee industry. The estimated levels of nickel exceed the WHO's lower safe limit of 0.10 mg 100 $g^{-1}$ ghee serving.

***Key words:*** Nickel contamination, Vegetable ghee, Hydrogenation.

## Introduction

Nickel is well known for its toxic effects on human health, which range from minor to severe pathological pulmonary disorders (Schroeder *et al* 1962 and Nielsen 1993). It is also well documented that nickel toxicity is associated with lipid peroxidation in the target organ (Dabeka and McKenzie 1995 and WHO 1989). The health hazards of nickel have thus caused concern among health authorities all over the world (WHO 1991a and WHO 1991b). In view of this, the daily total intake of nickel from various foods is laid down between 100-400 µg (Macdonald 1991 and Parr 1992). In developed countries, stringent control over the level of the metal during ghee manufacture is being legally regulated and exercised. Unfortunately, in developing countries, the state of affairs is far from being satisfactory. Nickel, used as a catalyst in the hydrogenation of edible oils for the manufacture of ghee, is subsequently removed from the reaction medium by filtration. The metal, however, permeates at various trace levels into the final product, ghee, which is a such abundantly used as a cooking medium by a large segment of Pakistan population (Dean and Ayub *et al* 1993).

The present study was undertaken to assess the present status of nickel contamination of locally produced vegetable ghee so as to help law enforcing and health authorities to evolve a control policy for decontamination of this toxic metal from an essential edible commodity.

## Material and Methods

Three batches of ghee samples were procured from local retailers, comprising of 19, 8 and 5 samples respectively (Table 1). All samples were collected in new, strong polythene bags of 1 kg capacity. Similarly, 7 edible oil samples (Table 3) were procured for the estimation of background nickel content. The solubilization medium for the samples was n-hexane which is well known for its efficient and stable thermal combustion characteristics and capability for improved flow rate of sample solution during aspiration. Quantification of results was based on standard calibration method, using a Shimadzu atomic absorption spectrophotometer (model AA-670), duly backed by automated background compensation facility. An exactly weighed (preferably 5.000 g) ghee/oil sample was transfered to a pre-washed and pre-dired 30 mL capacity centrifuge tube containing 20.0 mL of carefully measured n-hexane. The tube was given a swirling motion for about 1 minute, placed in the centrifuge rack and spun around at 3000 rmp for five minutes. After separating the settleable insoluble matter, the clear solution containing dissolved ghee/oil, which contained nickel in a dispersed form, was aspirated directly with the following operationals condition: $\lambda = 232.0$ nm; *HCL* current = mA; slit width = 0.15 nm; fuel (acetylene) flow rate = 0.9 $L^{-1}$min. The standards, within a range of 1-5 µg $g^{-1}$ nickel, were prepared from nickel phthalocyanine dye (FW 1148.11, 99% pure Merck) dissolved in hexane. The detection limit achieved was 0.010 ppm at x 10 expansion. Three to five replicates were simultaneously run and the results are reported as $\bar{X}\pm SD$.

## Results and Discussion

The results of various batches of ghee samples (Table 2) showed a substantial variability of nickel concentration in individual samples. The metal concentration was found to range from 0.445 mg 100$g^{-1}$ to 0.726 mg 100$g^{-1}$ for batch 1; from 0.668 mg

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**Table 1**

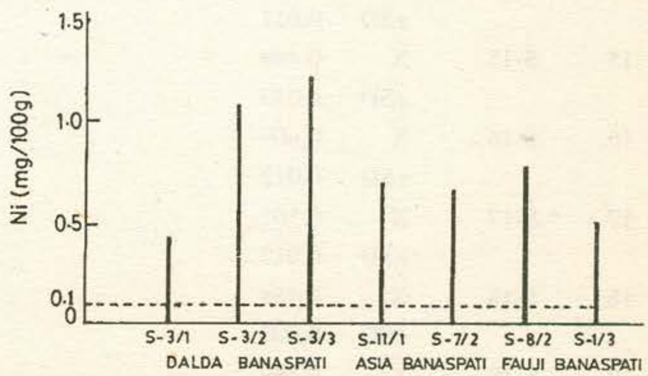
Sample codes and description of various vegetable ghee brands/batches analyzed for nickel

| Serial No. | Sample Code/Batch | Brand | Manufacturer |
|---|---|---|---|
| 1. | S-1/1, S-1/2 | Mujahid Banaspati | Hafeez Iqbal Oil & Ghee Industries |
| | S-1/3 | Fauji Banaspati | Waheed Hafeez Ghee Industries (Pvt) Ltd. |
| 2. | S-2/1, S-2/2 | Family Banaspati | Pan Asia Food Products (Pvt) Ltd. |
| | S-2/3 | | Tahir Oil Mills |
| 3. | S-3/1, S-3/2, S-3/3 | Dalda Banaspati | Lever Brothers Pakistan Ltd. |
| 4. | S-4/1, S-4/2 | Fauji Banaspati | Fauji Industries (Pvt) Ltd. |
| | S-4/3 | Sawaira Banaspati | Sawaira Ghee Industries |
| 5. | S-5/1, S-5/2 | Tullo Banaspati | Wazir Ali Industries Ltd. |
| | S-5/3 | ACP Banaspati | ACP Oil Mills (Pvt) Ltd. |
| 6. | S-6/1, S-6/2 | Zaiqa Banaspati | Punjab Oil Mills (Pvt) Ltd. |
| 7. | S-7/1 | Kohinoor Banaspati | Silver Oil Mills (Pvt) Ltd. |
| | S-7/2 | Asia Banaspati | Pan Asia Foods (Pvt) Ltd. |
| 8. | S-8/1 | ACP Banaspati | Waheed Hafeez Ghee Industries (Pvt) Ltd. |
| | S-8/2 | Fauji Banaspati | |
| 9. | S-9/1 | Anarkali Banaspati | Fazal Vegetable Ghee Mills |
| 10. | S-10/1 | Latif Banaspati | ACP Oil Mills (Pvt) Ltd. |
| 11. | S-11/1 | Asia Banaspati | Pan Asia Food (Pvt) Ltd. |
| 12. | S-12/1 | Haseeb Banaspati | ACP Oil Mills (Pvt) Ltd. |
| 13. | S-13/1 | Habib Banaspati | ACP Oil Mills (Pvt) Ltd. |
| 14. | S-14/1 | Kashmir Banaspati | United Industries Ltd. |
| 15. | S-15/1 | Kissan Banasopati | Kissan Ghee Corporation (Pvt) Ltd. |
| 16. | S-16/1 | Kauser Banaspati | Kauser Ghee Mills (Pvt) Ltd. |
| 17. | S-17/1 | POF Japan Banaspati | POF Ghee Industries |
| 18. | S-18/1 | GCP Banaspati | Ghee Corporation Pakistan Ltd. |
| 19. | S-19/1 | Kiran Banaspati | Kiran Ghee Industries |

$100g^{-1}$ to 1.268 mg $100g^{-1}$ for batch 2 and from 0.395 mg $100g^{-1}$ to 1.234 mg $100g^{-1}$ for batch 3. Maximum concentration was 1.268 mg $100g^{-1}$ (batch 2), 0.726 mg $100g^{-1}$ (batch 1) and 1.234 mg $100g^{-1}$ (batch 3) in ghee manufactured by Asia Foods, Tullo Wazir Ali Industries and Dalda Lever Brothers, respectively. The results indicated that even the leading ghee manufacturers were unable to cope with stringent quality control regarding nickel content of their finished product. On the whole, the average nickel content for batch 1 ghee samples was 0.589 mg $100g^{-1}$ for batch 2, the average concentration was 0.872 mg $100g^{-1}$ and for batch 3, it was 0.699 mg $100g^{-1}$. Batch 3 was found to contain maximum nickel; both reputed and non-reputed ghee manufacturers share this reputation.

The World Health Organization (WHO Report 1993) has laid down a lower safe limit of acceptable nickel content as 0.1 mg $100g^{-1}$ serving of vegetable ghee which, in the present case, enhanced to the level of 0.5 mg $100g^{-1}$. Only 7 ghee samples qualified for being acceptable from the viewpoint of safe ingestion (Table 2); thus, about 78% of the ghee brands contained unacceptable nickel level.

The results indicate that the current situation of nickel content of ghee is not satisfactory for consumers. A comparative evaluation of this situation is illustrated in Fig. 1. For example, in Dalda Banaspati the nickel content of batch 1 was almost 50% lower than that in batch 2, and it further increased in batch 3. Similar variations are also observed in other brands of ghee.




Comparative levels of nickel in various batches of ghee samples from a given manufacturer. (-------, *Limit recommended by WHO.*)

**Table 2**
Levels of nickel ($\bar{X}$±SD, mg $100g^{-1}$) in various vegetable ghee samples

| S.No. | Sample Code/ Batch 1 | Ni Level | | S.No. | Sample Code/ Batch 2 | Ni Level | | S.No. | Sample Code/ Batch 3 | Ni Level | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | S-1 | $\bar{X}$ | 0.667 | 20 | S-1 | $\bar{X}$ | 0.687 | 28 | S-1 | $\bar{X}$ | 0.514 |
| | | ±SD | 0.012 | | | ±SD | 0.013 | | | ±SD | 0.010 |
| 2 | S-2 | $\bar{X}$ | 0.640 | 21 | S-2 | $\bar{X}$ | 0.783 | 29 | S-2 | $\bar{X}$ | 0.339 |
| | | ±SD | 0.014 | | | ±SD | 0.009 | | | ±SD | 0.007 |
| 3 | S-3 | $\bar{X}$ | 0.445 | 22 | S-3 | $\bar{X}$ | 1.083 | 30 | S-3 | $\bar{X}$ | 1.234 |
| | | ±SD | 0.016 | | | ±SD | 0.014 | | | ±SD | 0.011 |
| 4. | S-4 | $\bar{X}$ | 0.535 | 23 | S-4 | $\bar{X}$ | 1.083 | 31 | S-4 | $\bar{X}$ | 0.657 |
| | | ±SD | 0.009 | | | ±SD | 0.016 | | | ±SD | 0.009 |
| 5. | S-5 | $\bar{X}$ | 0.597 | 24 | S-5 | $\bar{X}$ | 1.268 | 32 | S-5 | $\bar{X}$ | 0.697 |
| | | ±SD | 0.013 | | | ±SD | 0.016 | | | ±SD | 0.010 |
| 6. | S-6 | $\bar{X}$ | 0.556 | 25 | S-6 | $\bar{X}$ | 0.710 | | | | |
| | | ±SD | 0.012 | | | ±SD | 0.011 | | | | |
| 7. | S-7 | $\bar{X}$ | 0.539 | 26 | S-7 | $\bar{X}$ | 0.690 | | | | |
| | | ±SD | 0.009 | | | ±SD | 0.012 | | | | |
| 8. | S-8 | $\bar{X}$ | 0.502 | 27 | S-8 | $\bar{X}$ | 0.068 | | | | |
| | | ±SD | 0.007 | | | ±SD | 0.013 | | | | |
| 9. | S-9 | $\bar{X}$ | 0.571 | | | | | | | | |
| | | ±SD | 0.008 | | | | | | | | |
| 10. | S-10 | X | 0.495 | | | | | | | | |
| | | ±SD | 0.010 | | | | | | | | |
| 11. | S-11 | $\bar{X}$ | 0.726 | | | | | | | | |
| | | ±SD | 0.010 | | | | | | | | |
| 12. | S-12 | $\bar{X}$ | 0.531 | | | | | | | | |
| | | ±SD | 0.005 | | | | | | | | |
| 13. | S-13 | $\bar{X}$ | 0.609 | | | | | | | | |
| | | ±SD | 0.008 | | | | | | | | |
| 14. | S-14 | $\bar{X}$ | 0.495 | | | | | | | | |
| | | ±SD | 0.011 | | | | | | | | |
| 15. | S-15 | $\bar{X}$ | 0.494 | | | | | | | | |
| | | ±SD | 0.013 | | | | | | | | |
| 16. | S-16 | $\bar{X}$ | 0.609 | | | | | | | | |
| | | ±SD | 0.012 | | | | | | | | |
| 17. | S-17 | $\bar{X}$ | 0.501 | | | | | | | | |
| | | ±SD | 0.012 | | | | | | | | |
| 18. | S-18 | $\bar{X}$ | 0.458 | | | | | | | | |
| | | ±SD | 0.009 | | | | | | | | |
| 19. | S-19 | $\bar{X}$ | 0.569 | | | | | | | | |
| | | ±SD | 0.010 | | | | | | | | |

**Table 3**
Code, description and nickel content of various oils collected from local manufactures

| S.No. | Sample code | Nickel concentration (mg $kg^{-1}$) | Brand |
|---|---|---|---|
| 1. | SO-1 | 0.061 | Rafhan corn oil |
| 2. | SO-2 | 0.087 | Canola cooking oil |
| 3. | SO-3 | 0.080 | Sunflower cooking oil |
| 4. | SO-4 | 0.069 | Dalda cooking oil |
| 5. | SO-5 | 0.083 | Sharlo oil, UAE |
| 6. | SO-6 | 0.071 | Fauji oil (cotton seed) |
| 7. | SO-7 | 0.090 | Habib oil |

A total of 7 oil samples, used in the manufacture of ghee, were analyzed to investigate the nickel content originally present in these oils prior to hydrogenation. Irrespective of origin and type of oil, the range of nickel concentration found was between 0.061 $mg^{-1}kg$ and 0.090 mg $kg^{-1}$ (Roggi *et al* 1997). This, being the background concentration of nickel, could not contribute so heavily to the nickel content of ghee evaluated in the present study.

The majority of the ghee samples were found to contain undesirably high nickel levels as per WHO safe standards. It is high time that a control over the quality of ghee from the viewpoint of its nickel content be promulgated by the local law enforcing authorities.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