

NR Gloves in Contact with Food: Factors Affecting the Protein Transfer

H. HASMA*

Some NR latex gloves have been reported to transfer proteins to certain food on contact with gloves. The situation, however, could not be applied to all types of food and NR latex gloves. This study showed that no glove proteins were transferred to dry non-sticky food whereas the amount of proteins transferred to moist food is dependant on the extractable protein (EP) or antigenic protein (AP) content of the glove surface in contact with food.

Glove contact surface of EP content $<60 \mu\text{g}/\text{dm}^2$ or AP content of $<1.5 \mu\text{g}/\text{dm}^2$ could not transmit a measurable amount of proteins to nitrocellulose membrane which was used to simulate food with high binding affinity for proteins. On the other hand, only gloves with a higher AP level of $>10 \mu\text{g}/\text{dm}^2$ was found to transfer detectable amount of proteins to tomato and cheese. This inferred that NR gloves, especially powder-free gloves, with EP of $<60 \mu\text{g}/\text{dm}^2$ and/or AP $<10 \mu\text{g}/\text{dm}^2$ could be used in food handling.

Key words: NR latex; transfer; food; contact; gloves; proteins; extractable protein; antigenic protein; nitrocellulose; membrane

Gloves are used in food handling to act as a barrier against pathogens that may be on a worker's hands from illness, poor personal hygiene or from cross contamination. The common pathogens of high infectivity (ability to invade and multiply) and virulence (ability to produce severe disease) transmitted by food contaminated by infected persons are *Salmonella* Typhi (agent of typhoid fever), *Shigella* species, Shiga toxin-producing *Escherichia coli* and hepatitis A virus¹. However, reports^{2,3} on possible allergic reactions on sensitized people on contact with latex glove proteins adversely affect the use of NR gloves of superior barrier property⁴ in food service. This stems from the fear that latex gloves could transfer proteins to food, which on consumption may cause

sensitization or allergic reaction to sensitive individuals.

The fear against NR latex gloves is further aggravated by the report⁵ that latex gloves could transfer proteins to cheese and lettuce. It is noteworthy that the latter results were obtained by employing gloves with high residual protein content, and using the gloves inside (donning side) out to enhance the amount of proteins transferred to the food.

NR gloves are produced in different grades with minimal levels of proteins. Powdered and powder-free Standard Malaysian Gloves specified the EP level to be $<200 \mu\text{g}/\text{dm}^2$ and $<50 \mu\text{g}/\text{dm}^2$, respectively. With these differences and the limited data available

*Rubber Research Institute of Malaysia, Malaysian Rubber Board, P.O. Box 10150, 50908 Kuala Lumpur, Malaysia.

#Corresponding author (e-mail: hasma@lgm.gov.my)

on the transfer of latex proteins to food, it is quite unjustified to call for total avoidance of latex gloves in food handling⁶. The following study was thus undertaken to investigate the minimum extractable protein level from gloves that could contaminate the food on contact with the gloves. The study was further extended to assess the affinity of different types of food to bind latex glove proteins.

MATERIALS AND METHODS

Gloves and Food

Gloves were of NR latex examination gloves; powdered and powder-free while the food tested were lettuce, bread, tomato, cheese, beef and chicken burgers. All the food interfered with the non-specific protein test, the *ASTM D5712-99*, but not with the *ASTM D6499-03* and IgE-ELISA inhibition assays (except cheese).

Glove Proteins Transferred to Nitrocellulose Membrane

A piece of glove was cut from the palm region and a circle of diameter 0.65 dm was drawn on the gripping surface of the piece. The same circle size was cut from a nitrocellulose membrane. The membrane piece was soaked in 25 mM Phosphate Buffered Saline (PBS) and placed on the circled region of the gripping surface of the gloves at room temperature for 20 min. A glass plate was placed on top of the membrane to ensure a good contact between the membrane and the glove.

The glove piece was then fastened on a glass cylinder of 0.65 dm diameter and 1.5 dm high such that the circled tested region covered the mouth of the cylinder and facing inside the cylinder. Three mL of 25 mM PBS was pipetted into the cylinder and the glove surface

extracted for proteins for 30 min with regular shaking. Similar process was repeated with the control sample.

The extracts were collected and centrifuged at 3000 g for 15 min. The clarified extracts were assayed for protein content. The amount of proteins transferred to the membrane was calculated by subtracting the amount of proteins remaining in the film from the amount of proteins extracted from untreated film. The amount of proteins transferred was considered undetectable when the value is below the detection limit of the protein assay.

Glove Proteins Transferred to Food

A circular piece of diameter 0.65 dm was cut from dried lettuce, white bread, tomato, cheese, beef and chicken burger. The piece of food was then placed on the circled region of the gripping surface of the glove as done above. The rest of the procedure was as explained in the transfer of glove proteins to nitrocellulose membrane.

Protein Determinations

The EP and AP content were determined by *ASTM D 5712-99* method⁷ and *ASTM D6499-03* method⁸, respectively. The allergenic protein (AgP) was determined by IgE-ELISA inhibition method adapted from the test method developed by Palosuo *et al*⁹. The IgE antibodies were pooled human sera, which had been tested to contain specific antibodies to latex proteins. Fresh latex serum proteins were used as the standard allergens and a total protein concentration of 10 mg/mL was assigned to contain 100 000 allergen units (AU) per mL.

The detection limit of *ASTM D5712-99*, *ASTM D6499-03* and IgE-ELISA inhibition

is 4.7 $\mu\text{g/mL}$, 0.05 $\mu\text{g/mL}$ and 0.5 AU/mL, respectively.

RESULTS AND DISCUSSION

EP Content of the Whole Glove and Gripping Surface

The glove surface in contact with food would be the gripping surface; this is the surface in contact with the former and which has not been exposed to the on-line post-leaching treatment. The EP content from this surface is expected to be different from the total EP content of the whole gloves which is derived from both the gripping and donning surfaces. *Figure 1* shows the poor correlation between the total EP content of the whole gloves in comparison with the EP content of the corresponding gripping surface. However, the two parameters correlate quite well when the total EP values of the whole gloves were $<200 \mu\text{g/dm}^2$.

The EP content from the gripping surface of the current gloves constituted 30% to 70% of the total EP content of the whole gloves (*Figure 1*). This contradicted the earlier report¹⁰ which quoted a lower percentage of EP from the gripping side to be in the range of 2% to 6% of the whole glove total EP content. Although the percentage EP values differed, the actual EP values were not markedly different. EP content from the gripping surface of the present gloves ranged from 22 to 80 $\mu\text{g/dm}^2$ with one exception at 125 $\mu\text{g/dm}^2$ while that of the earlier gloves¹⁰ ranged from 11 to 76 $\mu\text{g/dm}^2$. The difference in the percentage EP values was mainly due to the difference in the total EP contents of the whole gloves. The total EP contents of the earlier gloves were in the high range of 460 to 1600 $\mu\text{g/dm}^2$, presumably due to the absence of post-leaching treatment on the glove donning side. The present gloves were, however, subjected to post-leaching

which resulted in a lower total EP content of $<300 \mu\text{g/dm}^2$.

Glove Proteins Transferred to Nitrocellulose Membrane

Nitrocellulose membrane is known to have a strong binding affinity for proteins and thus is used to simulate food that could have maximum binding propensity for glove proteins.

The transfer of glove proteins to food could involve extraction of proteins from the gloves prior to the binding of the proteins to food. The extraction process would be most affected by the level of moisture content of the food. Results in *Table 1* in fact showed that in the absence of moisture, as in dry membrane, the amount of proteins transferred to the membrane was minimal (7%). In this case the protein uptake could have depended solely on the affinity of the membrane to bind proteins.

On wetting the membrane with PBS or water, there existed a medium to extract proteins from the gloves. This resulted in higher amount of proteins adsorbed to the membrane. PBS, being a better extracting buffer, resulted in the membrane soaked in the buffer showing the highest uptake (78%) of the glove proteins.

In the subsequent tests of determining the levels of glove proteins transferred to the membrane, the membrane was pre-soaked in 25 mM PBS to optimise the extraction of proteins from the gloves when in contact with the membrane.

Table 2 shows that majority of powder-free gloves tested had the EP content of their gripping/contact surface $<60 \mu\text{g/dm}^2$. At this level no detectable amount of proteins were transferred to the membrane when in

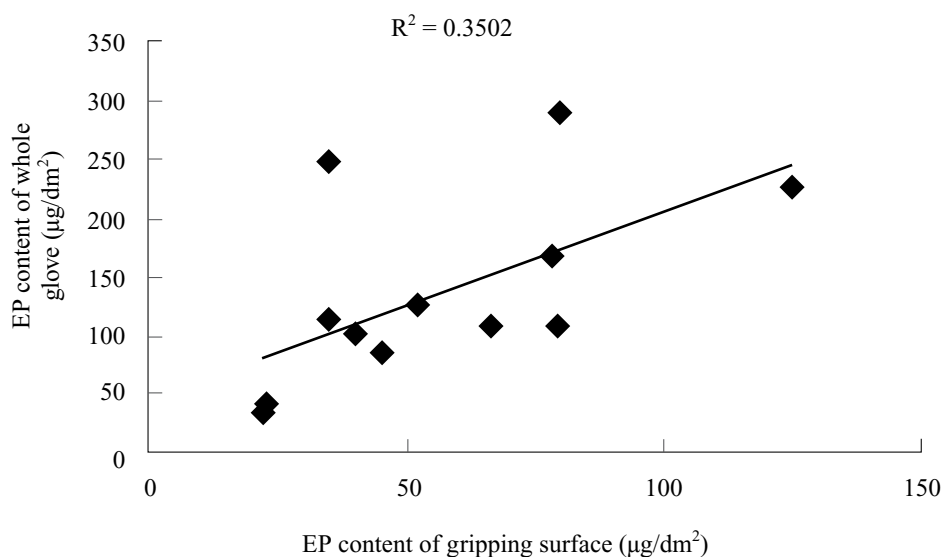


Figure 1. Total EP content of whole glove versus EP content from the corresponding gripping surface.

TABLE 1. PERCENTAGE OF PROTEINS ADSORBED TO NITROCELLULOSE MEMBRANE UNDER DIFFERENT CONDITIONS

| Membrane condition | Wetting agent | % Protein adsorbed |
|--------------------|---------------|--------------------|
| Dry | — | 7 |
| Wet | Water | 58 |
| Wet | 25 mM PBS | 78 |

TABLE 2. FRACTION OF NR LATEX GLOVES TRANSFERRING DETECTABLE AMOUNT OF PROTEINS TO NITROCELLULOSE MEMBRANE ON CONTACT WITH THE GLOVES

| Gloves | Transfer of extractable proteins | | Transfer of antigenic proteins | |
|-------------|---|-----------------------------|---|-----------------------------|
| | EP content of glove contact surface ($\mu\text{g}/\text{dm}^2$) | Glove fraction ^a | AP content of glove contact surface ($\mu\text{g}/\text{dm}^2$) | Glove fraction ^a |
| Powder-free | <60 | 0/18 | <1.5 | 0/12 |
| | 100 | 1/1 (81) | 1.5–2.5 | 7/7 (0.5–1.6) |
| Powdered | <60 | 0/3 | <1.5 | — |
| | 77–141 | 5/7 (54–86) | 3.1–16.4 | 9/10 (1.3–14) |

^a(Number of gloves showing detectable protein transfer to nitrocellulose membrane) / (total number of gloves within the protein range tested)

Values in brackets were the amount of proteins ($\mu\text{g}/\text{dm}^2$) transferred to the membrane.

contact with the glove surface. Similarly, no AP was transferred to the membrane when in contact with the gloves containing AP levels of $<1.5 \mu\text{g}/\text{dm}^2$. However, there were a few powder-free gloves with EP and AP content exceeding $60 \mu\text{g}/\text{dm}^2$ and $1.5 \mu\text{g}/\text{dm}^2$, respectively. In these instances measurable amount of proteins were transferred to the membrane.

On the contrary most of the powdered glove gripping surface contained EP $> 60 \mu\text{g}/\text{dm}^2$ and AP $>1.5 \mu\text{g}/\text{dm}^2$. This caused majority of the tested powdered gloves to transfer measurable amount of proteins to the membrane (*Table 2*). However, three powdered gloves contained EP of $<60 \mu\text{g}/\text{dm}^2$ and these gloves showed non-detectable amount of proteins transferred.

The above data indicated that the level of proteins transferred to the membrane depended on the amount of proteins on the glove gripping/contact surface. The minimum level of EP and AP content of the glove gripping surface for detectable transfer of proteins to the membrane seemed to be $60 \mu\text{g}/\text{dm}^2$ and $1.5 \mu\text{g}/\text{dm}^2$, respectively. As majority of powder-free NR gloves have EP and AP below the above mentioned limits, they are the gloves that could be used in handling food with high propensity to extract and bind glove proteins.

Glove Proteins Transferred to Food

Specially prepared gloves (without post-leaching) with its donning side containing $35.7 \mu\text{g}/\text{dm}^2$ of AP and $1082 \text{ AU}/\text{dm}^2$ of AgP was allowed to be in contact with different types of food of varying moisture content. As observed with nitrocellulose membrane, dry food (lettuce and bread) showed non-detectable amount of proteins being transferred (*Table 3*).

Sticky food like cheese and cucumber bound appreciable amount of proteins. This was equivalent to the level bound by watery food, tomato, and processed beef burger and chicken burger. Approximately equal percentage of AgP was adsorbed by cucumber, tomato, beef and chicken burger. These results showed that the transfer of glove proteins to food depended on the nature and moisture content of food.

It is noteworthy that the above experiments were specially designed with gloves of high protein content. Currently produced gloves were all post-leached and with a much lower protein content (*Table 2*).

When gloves of different protein levels were experimented with tomatoes and cheese, the levels of protein transferred depended on the AP content of the glove contact surface. It was observed that majority of gloves (powdered gloves) with AP content of $>10 \mu\text{g}/\text{dm}^2$ transferred detectable amount of proteins to cheese and tomatoes (*Table 4*). On the other hand, powder-free gloves (both chlorinated and polymer coated) with AP $<10 \mu\text{g}/\text{dm}^2$ showed less chances of contaminating the food, making them the gloves of choice in food handling.

CONCLUSION

The transfer of latex proteins to food was dependent on the protein content of the glove surface in contact with food and the nature of food. Powder-free gloves with antigen level $<1.5 \mu\text{g}/\text{dm}^2$ could not transfer detectable amount of proteins to surrogate food with high affinity for proteins. A higher AP level of $>10 \mu\text{g}/\text{dm}^2$ was required to transfer proteins to cheese and tomatoes. However, glove proteins were found unable to migrate to dry, non-sticky food.

The study showed that powder-free NR latex gloves could be the glove of choice in the food handling industry.

TABLE 3. PERCENTAGE OF PROTEINS TRANSFERRED TO DIFFERENT FOOD ON CONTACT WITH DONNING SURFACE OF SPECIALLY PREPARED NON-POST LEACHED GLOVES

| Food | Remark | % AP | % AgP |
|----------------|----------------|------|------------|
| Lettuce | Dry | Nd | Nd |
| Bread | | Nd | Nd |
| Cheese | Semi-dry | 65 | Interfered |
| Cucumber | | 58 | 50 |
| Tomato | Watery | 55 | 54 |
| Beef burger | Processed food | 70 | 63 |
| Chicken burger | | 53 | 41 |

Nd: Non-detectable

TABLE 4. FRACTION OF GLOVES TRANSFERRING DETECTABLE AMOUNT OF ANTIGENIC PROTEINS TO CHEESE AND TOMATOES

| Food | AP content of glove contact surface ($\mu\text{g}/\text{dm}^2$) | Glove fraction ^a |
|--------|---|-----------------------------|
| Cheese | <10 | 2/13 (0.7–1.1) |
| | 12.0–36.8 | 4/7 (2.0–8.3) |
| Tomato | <10 | 1/24 (2.8) |
| | 10.5–36.7 | 8/15 (1.7–32.7) |

^a(Number of gloves showing detectable protein transfer to food) / (Total number of gloves within the protein range tested)

Values in brackets were the amount of proteins ($\mu\text{g}/\text{dm}^2$) transferred to the food.

ACKNOWLEDGEMENT

The author would like to thank the Director General of Malaysian Rubber Board for the permission to publish the paper. Special thanks to Dr Amir Hashim and Dr Lai Pin Fah for their interest in the work and to Vijayalaksmi K. and Mohd Yusof Rais for their excellent technical assistance.

Date of receipt: November 2005

Date of acceptance: June 2006

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