4 CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to determine whether irradiation of flour prior to cooking could alleviate the reduction in protein digestibility that occurs when sorghum flour is cooked into porridge. From the results obtained in this study, it emerges that this is possible.

Irradiation of flour before cooking can alleviate the negative effects of cooking on sorghum protein digestibility. This alleviation appears to be favoured by mild irradiation (10 kGy dry), and appears to occur through a change in protein structure brought about by irradiation breaking hydrogen and disulphide bonds in sorghum proteins, that in turn can reduce disulphide crosslinking during cooking. This apparently results in a more unfolded and open protein network, exposing additional peptide bonds to pepsin hydrolysis. Because 10 kGy was the lowest irradiation dose used, and it alleviated the reduction in protein digestibility most, it is recommended that the effects of lower doses (< 10 kGy) of irradiation on sorghum cooked protein digestibility be investigated. Sorghums, especially condensed-tannin free cultivars are prone to insect damage. If low dose irradiation such as used in insect disinfestations (0.5-5 kGy) as recommended by the International Consultative Group on Food Irradiation, ICGFI (1991), can give better cooked protein digestibility in sorghum, it may combine prolonged shelf life with better nutritional quality that in turn can contribute towards food security. In addition, lower doses of irradiation may cause less damage to proteins and other food components such as starch and vitamins.

Although, irradiation of sorghum flours under severe conditions (50 kGy dry and 10 and 50 kGy wet) also relieves the reduction in protein digestibility of their cooked porridges, the beneficial effects are however diminished compared to low dose irradiation (10 kGy dry). It appears that covalent non-disulphide crosslinks, such as Maillard crosslinks, lysinoalanine and bityrosine may be formed under severe conditions of irradiation. This may have caused refolding and closing up of the protein structure, resulting in the masking of some previously exposed digestible peptide bonds. It is recommended that the participation of bityrosine crosslinks and lysinoalanine formation in protein polymerisation of sorghum and maize be determined. In addition, the extent of protein breakdown and polymerisation should be assessed in order to gain more understanding into the mechanism by which irradiation prior to cooking alleviates the reduction in cooked sorghum protein digestibility.

In the case of maize, whose proteins are similar to those of sorghum, irradiation of dry flour before cooking does not have a significant effect on the protein digestibility of their porridges, but when flour samples are irradiated in wet medium before cooking the digestibility of their porridges decreases compared to porridges from unirradiated flour. It seems that the presence of fewer disulphide bonds in uncooked maize flour compared to sorghum does not allow for significant changes in its protein structure when irradiated in dry form, whereas under wet (severe) conditions of irradiation, the formation of covalent non-disulphide bonds as in the case of sorghum may result in a direct negative effect on maize protein digestibility.

It appears that polyphenols in sorghum BR7 can act as antioxidants, scavenging free radicals during irradiation, thus influencing the extent of radiation damage in these proteins. NSI in BR7 did not change significantly with irradiation possibly due to polyphenols scavenging free radicals and reducing the extent of radiation damage. However, under severe conditions of irradiation, the oxidised polyphenols may have been converted to free radicals that reacted with the AG proteins, causing the greater reduction in solubility of AG proteins in sorghum BR7 with irradiation alone.

Although irradiation can somewhat alleviate the reduction in cooked sorghum protein digestibility, the practical application of this technique to improve the nutritional quality of sorghum porridge may not be immediately appealing considering the high initial capital investments. However, in areas where irradiation facilities already exist, this may not be so. It is therefore, important to take into account all the benefits that irradiation could offer in terms of nutritional quality and safety that could offset the cost of irradiation.

Irradiation does affect other components within the food such as carbohydrates and lipids. Previous studies in our laboratory had shown that irradiation of maize flour at low dose (2.5 kGy) can cause depolymerisation of starch leading to a reduction in viscosity and an improvement *in vitro* starch digestibility. Because of the reduced viscosity nutrient dense porridges could be made from irradiated maize flours. If such can occur in sorghum, then combining these benefits with better protein digestibility will make irradiation even more desirable. In addition, nutrient dense high digestible porridges may assist to some extent towards alleviating malnutrition in sorghum consuming areas.

Since the reduction in protein digestibility of sorghum occurs during cooking, and is due to disulphide crosslinking of their proteins, it is recommended that irradiation be investigated on the cooked porridges. If effective at improving protein digestibility, it could also provide a means of producing safer pre-cooked sorghum porridges, given that irradiation can have pasteurising and sterilizing effects, depending on the dose used.

In conclusion, irradiation is a potentially useful technique of processing that can improve nutritional quality and safety of sorghum foods, given that it can improve protein digestibility and nutrient density, and at the same time destroy pathogenic and spoilage micro organisms.