Summary and conclusions
SUMMARY AND CONCLUSION

The present study was conducted to survey, 106 Gujarati households for the consumption, preparation and storage practices of the popular cereal-pulse based fermented food 'handwa', to standardise and characterise the product, and to explore the scope of technology modifications to suit the sensory and nutritional needs of various target groups. This chapter summarises the important findings of the study and conclusions derived from it.

* The survey results highlighted the variations in the methods of handwa consumption, preparation and storage practices of Gujarati families belonging to various income groups.

- Almost 85% of the families consumed handwa as a major meal of the day, dinner being the most preferred occasion. Most families consumed handwa along with groundnut oil, tea, milk, chutneys etc.

- The mix used for the preparation of this product is not a standard one and varies from house to house in terms of choice of ingredients and its relative proportion. The most popular handwa mix consisted of rice, red gram and bengal gram dal used in the ratio of 3:1:1 respectively.

- Lactic fermentation was practiced more than the natural fermentation.
Baking was carried out in a traditional handwa oven by almost 80% of the families surveyed. These families reported baking time to be ranging from 30-90 min depending upon the desired degree of doneness, quantity of handwa being baked and time-temperature conditions.

The minimum shelf life of 16 h was reported for the leftover handwa during summer.

The most desirable attributes for good quality handwa were reported to be soft crumb texture, followed by the presence of golden brown crust and spicy flavour.

* The standardisation of handwa was carried out by using the most popular mix with respect to choice of rice, baking conditions, mesh size of the mix, water content of batter and fermentation.

- The use of parboiled rice was found to be a better choice as compared to ordinary rice since it resulted into handwas with higher overall acceptability (OA) scores and total scores.

- Baking of handwas in sandbath and handwa oven for 80 min by keeping the gas flame high for initial 10 min and reducing it to minimum for rest of the baking period resulted in handwas with most desirable sensory qualities.

- The mix particle size which resulted into handwas with good textural qualities ranged from 25 μ to 75 μ.
As regards batter moisture content, 50 g of batter mix prepared with water content ranging from 70 to 85 ml gave handwas with the most desirable sensory qualities.

Fermenting the batter for 12 h using the natural culture developed in the laboratory by the back sloping method resulted in handwas with the higher OA scores and total scores along with the development of other desirable qualities.

* The gross composition and shelflife was studied for handwas prepared from a typical handwa mix (30 g rice flour + 10 g red gram flour and 10 g bengal gram flour) with 15 ml oil, 2.5 g each of sugar, salt, sesame seeds, and mustard seeds, and 8 g of fresh green spices.

- The standard handwa had a moisture content of 47.2%, 10.32% protein, 25.31% fat, 59.79% carbohydrates, 2.04%.

- Upon storage in both the refrigerator and at room temperature, the moisture content of handwas decreased significantly. These handwas could be stored at room temperature (22-34°C) for 18 days and for five months in the refrigerator without significantly affecting the flavour and overall acceptability scores.

* The technology modifications in handwa preparation was carried

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out with respect to substitution of cereals and pulses other than those commonly used in the handwa preparation, use of germinated pulses, use of vegetables, use of nonconventional devices for baking purpose, use of steaming along with baking operations and developing ready to bake handwa mixes.

- Acceptable handwas could be prepared by substituting rice with sorghum and maize upto 25%, and with wheat and pearl millet upto 10%. Incorporation of these cereals also brought about significant reduction in the pH of batters as compared to only rice fermented batters.

- Pulses other than red gram and bengal gram dals such as broad beans, moth beans, black gram dal, lentil, peas and green gram dal could be incorporated in handwas upto 25% without significantly affecting the flavour and overall sensory qualities. Higher levels of incorporation however brought about a significant reduction in the flavour and overall acceptability scores for all the handwas.

- The typical handwa mix containing rice and germinated powders of red gram and bengal gram with 15% less batter moisture, resulted in handwas that were comparable to the controls with an additional advantage of reduction in the baking time by 20 min.

- Vegetables such as string beans and cluster beans could
be incorporated in handwas (15 g per 50 g mix) without making any significant changes in the overall sensory qualities of handwas. The okra added handwas were less liked due to the development of uncharacteristic flavour and was considered too moist compared to the controls.

- Vegetables such as bottle gourd could be added to handwas in either grated or ground form without making any significant change in the specific volume or the sensory qualities of handwas.

- The combination of 10 min steaming followed by 50 min baking reduced the overall cooking time from 90 min to 60 min represented by a reduction of one third the cooking time, without affecting the physical and sensory qualities of handwas.

- Acceptable handwas could be prepared using the newer varieties of baking devices such as microwave and solar ovens with respect to most of the sensory qualities except the development of the golden brown chewy crust which is desired in a typical handwa.

- The ready-to-bake mixes, could be effectively formulated with the dry mixing of baking soda (as the leavening agent) in to the handwa mix containing citric acid as acidulant, spices, vegetables. These mixes could be stored for one year without bringing any significant changes in
The flavour and the overall acceptability scores of the handwas prepared from them.

* The nutritionally balanced handwa formulations were computed for various target groups such as the adult man, woman, adolescents, pre-school and school age children.

- These handwas differed significantly from the standard handwa formulation, especially in terms of the cereal-pulse ratio, fat and mineral content.

- Due to the alterations in their composition, handwas prepared from balanced formulations were significantly different from the control in terms of low cell size, moistness, flavour and overall acceptability scores.

- In order to improve the sensory qualities of balanced handwas, the balanced handwa formulations for three selected target groups were blended with the standard handwa formulations at the levels ranging from 20% to 80%. Acceptable handwas comparable to the controls could be prepared by blending 80% balanced and 20% standard formulation for adolescent boys whereas only 40% of standard formulation was required in the blend to make acceptable handwas for school goers and 80% in case of adult man.