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DISCUSSION

This study was undertaken to standardise handwa making technology on the basis of the product profile developed from a limited survey conducted on Baroda based, handwa making gujarati families. The product profile of handwa was gathered by surveying those gujarati families who make handwa for household consumption. Since the purposive sampling included only those families (108) who prepare and consume handwa, it is not possible to learn from this survey what percent of total gujarati families do in fact make or consume handwa.

Even though the survey indicated that the most popular mix ingredients were rice, bengal gram and red gram dals in the ratio of 3:1:1, such a mix was used only by 30% of the population sampled and even amongst them, the proportion of these ingredients varied considerably for rice (22 g to 80 g), bengal gram dal (11 g to 28 g) and red gram dal (17 g to 30 g). Majority of the population (i.e. the remaining 70%) used a variety of ingredients which added up to about 14 different handwa mix combinations. Therefore, handwa, in comparison to many other household food items, appears to be much less standardised and large variations are accepted.

Large variations in the choice of ingredients, their relative proportions, variations in manufacturing steps are bound to result in widely different products that are termed 'handwa.'
Inspite of these inherent differences in the household handwas, there appears to be some appreciation for the desirable quality of handwa which, according to the survey, was to possess a golden brown crust, soft crumb texture, and a characteristic spicy and acidic flavour.

Studies on the standardisation of various manufacturing steps revealed that beyond certain limits, variations in the choice of ingredients and their relative proportions in the mix, particle size of the mix, methods of batter making, fermentation techniques and baking conditions can result in handwas of unacceptable quality. Amongst the ingredients that can be used for handwa, the use of wheat and pearl millet beyond 10% appears to be most critical. Although wheat, due to its gluten content, is the crucial ingredient for breads, cakes and similar varieties of baked products, its excessive use in handwa results in higher acidity and moisture retention, affecting the handwa quality. To some extent addition of millets along with wheat counteracted the undesirable effects of wheat.

Unlike cereals, pulse substitution caused less problem with body and texture of handwa. However the flavour in those cases, were criticized as atypical of handwa.

Substitution of ingredients in the handwa mix is likely to affect the activity of handwa culture which was developed from a typical rice-bengal gram-red gram batter mix. This in turn could affect the pH, body texture and flavour of handwa.
Although lactic cultures commonly used in dahi are being used by many families for fermenting handwa batter, our study revealed that the culture developed by 'back-slopping' method appears to work more consistently under a wide set of handwa making conditions. According to Ramakrishnan (1979), microflora normally found in the cereal-pulse combined mixes, as in case of idli and dosa were found to be different in the household samples from those found in commercial food establishments. While yeast predominated in the idli-dosa batters of commercial houses, Lactobacillus mesenteroides predominated the household batter mix. In our study, no attempt was made to isolate and characterise different fermentation micro organisms that were found in the cultures, developed by back-slopping method, and were used throughout the study.

The simple step of preparing batter can be critical to the quality of resultant handwa as this step can influence the progress of fermentation in batter and the retention of moisture in handwa. Both excess and reduced moisture level can adversely affect the fermentation process which in turn can affect the resultant pH of the batter mix and flavour of the final product. Since pH is important to several reactions, particularly, the gelformation, and heat induced coagulation of proteins, its variation may affect the resultant body and texture of handwa.

Under the standardised baking conditions, initial moisture levels can influence the completion of the cooking step (i.e. the doneness) particularly if the moisture is too low, which may also
result in a 'dry' handwa. Excessive moisture on the other hand, may leave a higher content of residual moisture, making the product too moist, and soft.

In our study, it has been possible to obtain handwa of satisfactory quality from different mixes, by adjusting batter moisture levels, depending on the inherent moisture holding tendency of any particular experimental system. Thus, this simple step of batter preparation can be of crucial importance in the control of handwa quality.

This study has also demonstrated the feasibility of using a sandbath, box type solar cooker, and microwave oven as different means for baking handwa, in addition to the use of the traditional handwa oven. Using about 4-6 containers (each with 165 ml of batter mix) in a sandbath, handwa baking could be completed normally in 90 min, with initial preheating of sandbath for 5 min at high flame, baking at high flame for another 5 min, followed by slow flame baking for 80 min. This 90 min baking time could be further reduced to 60 min by introducing 10 min steaming followed by 50 min baking procedure. In household conditions, handwa baking usually involves a larger amount of batter (1-2 liters) in a traditional handwa oven of 3-4 liters capacity. Other means of reducing the total baking time can also be explored by making a judicious combination of the time-temperature conditions and the batter moisture level.

Baking of handwa involves heat penetration into the batter

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mass essentially by conduction. Similar to the baking of bread, several essential processes continue to take place, including the expansion of the batter volume, cooking of the protein-carbohydrate components of cereal and pulses, moisture evaporation, and ultimately the development of golden brown crust.

The rate of heat penetration depends on both temperature gradient (which is controlled by the oven) and the volume of the batter mass. Larger the diameter/depth of batter mass, slower is the rate of heat penetration. Thus for a given oven system, it is necessary to standardise the baking procedure. For a large size commercial production, the baking data requires to be re-established on the basis of the trends indicated in the sandbath trials (with 120-160 g units of 4-6 containers).

Our study also revealed that compared to the baking of one handwa in 2-3 kg sizes, equally good quality handwa could be obtained in 15-20 smaller containers, creating convenience in the form of individual servings. Such handwas can be kept protected in the containers until use. A large size handwa will have to be sliced into smaller pieces for serving which cause exposure of the handwa that might result in part dehydration, loss of flavour, and reduce its shelf-life in the leftover pieces besides having a high loss in broken pieces. In contrast, the small size individual containers can be taken directly from the oven, and kept unopened until use. This might explain a rather long shelf life of handwas observed in our studies, regardless of the temperature of storage. While the housewives felt (in the survey) that handwa could keep
for not more than 2 days at room temperature during summer months, in our studies, under the similar conditions, handwa was kept for 15-18 days. It should be therefore possible to bake, pack, and serve handwa in the manner similar to the cakes and pastries.

When the development of ready-to-reconstitute-and-bake handwa mixes was undertaken, there were only the general purpose mixes available from the millers for the preparation of handwa and dhoklas. These mixes required the usual fermentation step prior to baking. Subsequently, a few commercial mixes containing citric acid and sodium-bi-carbonate began to appear in the market. These mixes still required the addition of freshly ground green spices and vegetables prior to the seasoning and baking of the batter. The handwa mix developed on the basis of our study, takes care of these shortcomings, requiring only the seasoning step (vaghar) prior to baking.

Although the R-B mixes developed in this study involved the use of mix comprising parboiled rice, red gram and bengal gram dal in the ratio of 3:1:1, it should be possible to try out many more combinations of cereals and pulses without affecting the sensory qualities as well as nutritional qualities of handwas prepared from them. Large number of ingredients of choice is not convenient for household but might be economic for commercial mix preparation without sacrificing sensory and nutritional quality.

Even though no special care was taken in degassing the mix and packing under nitrogen atmosphere, good quality handwa was obtained at the end of one year storage of these mixes. Under the

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commercial conditions of transportation, storage and handling, such product is expected to be usable for at least six month period. Improved packaging systems are likely to boost the shelf life further.

Although the storage study on freshly prepared handwas indicated isolated incidents of the occurrence of yeasts, molds and coliforms, under the commercial situation, it should be possible to control such incidents by means of employing better aseptic conditions and appropriate packaging materials.

Although the formulation of balanced diet on the basis of a rather limited number of ingredients, is considered unlikely, such an attempt was made in our study due to the realization that an assortment of cereals, pulses and vegetables that are available throughout the year and all over India could be used for formulating handwa mix. Handwa, therefore, could be balanced in terms of major nutritional requirements particularly calories, proteins, lipid, calcium and iron.

Our study revealed that a typical handwa is far from being balanced with reference to the nutritional requirements of any particular population group (i.e. adult man, woman, adolescents and school age children examined in our study). However, handwas prepared from mixes nutritionally balanced for the three particular target groups (i.e. adult man, adolescent boys and school age children of 7-9 yrs) were not acceptable to the judges. The modified handwas were very different from the controls in

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terms of body, texture and flavour, largely due to the altered cereal-pulse ratio and fat. During the evaluation of balanced handwas, it was observed that, amongst the panel members, the traditional handwa eaters were more critical about the balanced handwas for their sensory qualities especially flavour, than the non traditional handwa eaters, who were willing to accept the modified product even though these were not typical handwa. Therefore, such a product has a scope to be popularised as a nutritious variety, all over India, where the typical handwa has not yet been established in their regular diets. Their acceptability can be improved by introducing suitable spice combinations.

Providing a cereal-pulse based balanced food in the form of handwa which is dry, non sweet, easily handelable entity, offers a convenient alternative to all-too-well-known gruels and "khichdis". Introducing these nutritionally balanced handwas might however require concerted motivational efforts. This study has proven that handwa can be prepared with a variety of ingredients and spice combinations to suit the local and seasonal availability, and preferences using several baking methods. Such food could provide all over India an additional variety, offering cereal-pulse based foods. Handwa has the potential to grow in popularity beyond Gujarat and its neighbouring states as has been the case with idli and dosa of south.

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