

RESEARCH ARTICLE

Development of ready to cook vegetable khichadi mix by microwave drying technology

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ABSTRACT

This study was undertaken with the objectives of to develop ready to cook Vegetable Khichadi Mix and to optimize its procedure by using microwave drying technique. Instant Vegetable Khichadi is formulated with use of parboiled rice, red gram dhal, green gram dhal and vegetables (Cauliflower, French beans, green peas and carrot). Raw ingredients were converted into instant by soaking and cooking followed by microwave drying (100 W). Instant Khichadi mix was formulated by using various combinations of selected samples of dehydrated rice, dhals and vegetables. The best combination of Instant Khichadi was selected based on sensory analysis (9 point hedonic). Per serving size (100gm) of the Instant Khichadi included 60g rice, 20g dhal and 20g vegetables and required 5 min to cook. Under ICDS, Instant Khichadi Mix can be suggested as a means of supplementary nutrition to incorporate healthy, nutritious food.

Keywords: Instant khichadi, microwave drying, rice, ready to cook, vegetables

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INTRODUCTION

The term Khichadi derived from Sanskrit “Khicca”, a dish from Indian subcontinent made with a mixture of rice and lentils which is loaded with wholesome goodness, easy to digest and free of gluten. It is a salty porridge and a comfort food, owing to the convenience of being able to cook in a single simmering pot (Hemant et al., 2015). Ready to Cook vegetable Khichadi mix is a precooked microwave dried mixture of parboiled rice, red gram dhal, green gram dhal and vegetables like cauliflower, carrot, french beans and green peas.

The use of microwave drying has increased in the last few decades because of more accurate process control, good penetration power, low temperature and short process time (Sharma and Chandra, 2017). Microwaves penetrate to interior of the food leading water to get heated within food. This results in a high vapor pressure allowing moisture out of the food at faster rate. Hence, application of microwave energy to dehydrate food is a good approach for coping with certain drawbacks of conventional drying. A domestic microwave oven works by passing microwave radiation, usually at a frequency of 2450 MHz through the food (Sutar and Prasad, 2008).

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Rice (*Oryza sativa L*) is the staple food for over half the world's population. Parboiling is a hydrothermal treatment given to rough rice consists of three steps: soaking, cooking and drying. This special processing makes parboiled rice is a better source of fiber, calcium, potassium, zinc and niacin than regular white rice. While parboiling, starch get partially gelatinize to seals off fissures, improves kernel strengthening and yields a grains more resistance to breakage. Parboiled rice also contains less starch (Veronica et al., 2018). These features makes parboiled rice is a choice for drying.

Primary protein supply in daily diet comes from legumes. High protein content, along with energy values and important vitamin and mineral content, legumes has been recognized for their nutritional importance. Amongst these, pigeon- pea or red gram (*Cajanus cajan L.*) is economically and nutritionally an important legume and is a major source of protein for the poor communities of the world (Sharmal et al., 2011). Green gram (*Vigna radiate*) is high in protein and yet easily digestible with less anti-nutritional and the bonus of extra fiber makes this a super food (Alpana et al., 2017).

In India root and leafy vegetables or green plants have been used in the diet are highly beneficial for health as they are important source of vital micro nutrients. Vegetables are important in improving the acceptability of meal, because of the innumerable shades of colour, flavor and texture they contribute (Sharma and Prasad, 2018). Cauliflower (*Brassica oleracea*), Carrot (*Daucus carota L.*), French beans (*Phaseolus vulgaris*) and Green peas (*Pisum sativum*) are considered a good source of dietary fiber, vitamin A, B group vitamins, vitamin C and minerals like calcium, phosphorus, iron and magnesium (Bux et al., 2015).

The present work was undertaken with the objectives (i) To develop instant rice, instant dhal (red gram and green gram) and instant vegetables by microwave drying technique and to study its physicochemical properties. (ii) To formulate a high nutritional quality ready to cook Vegetable Khichadi Mix. (iii) To provide fascinating solution to the working populations by providing them a convenient product. (iii) To carry out chemical analysis of final product.

MATERIALS AND METHODS

Materials

The present work was completed in the laboratory of Food Science and Technology, SUK. Parboiled rice, red gram dhal, green gram dhal and fresh vegetables were procured from local market of Kolhapur.

Methods

Microwave drying method was chosen for this present study. Microwave oven of Onida- Power Convection 25 was used. The research study was carried out in following phases.

Preparation of Instant Rice

For the preparation and optimization of instant parboiled rice, first rice samples were cleaned and washed with ample amount of water for three times. Then they were soaked for 0, 15, 30, 45, 60 and 90 min respectively, excess water was drained, cooked and dried in microwave at 100 W (Bencharat et al., 2012). Cooking test for rice samples (Ranghino Test) was taken as described by Rao (2018).

Preparation of Instant Dhal

Same procedure like parboiled rice was followed for preparation and process optimization of instant red gram dhal and instant green gram dhal (Ghadge et al., 2008).

Preparation of Instant vegetables

Vegetables like cauliflower french beans, carrot and green peas were prepared for drying as per the procedure described by Pandey et al. (2016). All vegetables were first cleaned / trimmed, washed, cut (cauliflower was cut into small pieces, green peas were taken as it is and carrot and French beans were cut into pieces of 5mm length*3mm width), steam blanched and dried in microwave (80 W).

Rehydration

The 10 gm of dehydrated samples were boiled with 100 ml water till they become soft and attained the consistency of cooked product. The excess water was drained and rehydration ratio was calculated by the below given formula (Prasert and Suwannaporn, 2009). Rehydration time was also noted down.

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated sample}}{\text{Weight of dehydrated sample}}$$

Formulation and Sensory of Vegetable Khichadi Mix

Three different formulations of Vegetable Khichadi Mix were prepared by taking varying proportions of parboiled rice, Dhal (red gram dhal and green gram dhal in equal quantities) and vegetables respectively; which were selected on the basis of physicochemical properties. Formulations are VKM F1 50:30:20, VKM F2 60:20:20 and VKM F3 70:10:20. Each formulated sample was rehydrated by adding 100 gm of sample to 500 ml boiling water. Salt and other spices added as per taste and choice. Rehydration characteristics of samples were studied and samples were evaluated by 15 semi trained panelists on 9-point hedonic scale (9- like extremely to 1- dislike extremely) for acceptability.

Chemical Analysis

The formulation of Vegetable Khichadi Mix which was ranked highest in sensory evaluation was subjected to chemical analysis for moisture, carbohydrates, proteins, fat, fiber, ash, vitamin C and iron (AOAC, 2005).

RESULTS AND DISCUSSION

The results from dehydration of rice, dhal and vegetables and formulation of Vegetable Khichadi mix were reported and discussed below.

From the above observations in Table 1, it was studied that soaking time have significant effect on appearance of rice samples. The pre-soaked samples of rice more than 30 min tended to have non sticky texture. This could be a result of amount of starch leached when soaked for longer time prior to cooking. Similar results were reported by Rewtong et al. (2011). With regards to rehydration time and ratio, soaking time have positive effect on both. Ratio of rehydration was found to be increased with increase in soaking time prior to cooking. Also the increase in soaking time leads to increase in time required

for dehydration. So, by considering above results, the rice sample which has been soaked for 90 min was selected for the formulation of Vegetable Khichadi Mix as it was showed good physicochemical properties as compared to other samples.

Table 1: Physicochemical Properties Dehydrated and Rehydrated Parboiled Rice

Soaking Prior Cooking (min)	Drying time (min)	Moisture in Dried Sample (%)	Rehydration Time (min)	Rehydration Ratio	Appearance (stickiness, lumps & brokens)
0	12	5.79	7	5.0	Sticky, few lumps, no brokens
15	12	5.80	6	5.2	Sticky, more lumps, no brokens
30	12	6.12	6	5.2	Sticky, few lumps no brokens
45	14	6.38	5	6.5	Non sticky, few lumps, no brokens
60	14	6.06	5	6.8	Non sticky, few lumps, no brokens
90	15	6.02	5	6.5	Non sticky, no lumps, no brokens

Table 2: Physicochemical Properties of Dehydrated and Rehydrated Red Gram and Green Gram dhal

Soaking Prior Cooking (min)	Drying Time (min)		Moisture in dried sample (%)		Rehydration Time		Rehydration ratio		Appearance (lumps and brokens)	
	RGD	GGD	RGD	GGD	RGD	GGD	RGD	GGD	RGD	GGD
0	10	6	5.12	5.75	8	6	3.0	3.5	Nil	Nil
30	10	6	5.32	6.02	6	4	3.0	4.0	Nil	Nil
60	10	7	5.29	6.03	5	4	4.0	3.5	Nil	Nil
90	11	7	6.01	5.19	4	3	4.0	4.0	Nil	No lumps, few brokens
120	11	8	5.60	6.10	4	3	4.0	4.0	Nil	No lumps, few brokens
150	12	9	6.13	5.41	3.5	3	4.0	3.5	Nil	No lumps, more brokens
180	12	9	6.10	6.08	2	3	4.0	4.0	Nil	No lumps, more brokens

RGD- Red Gram Dhal GGD- Green Gram Dhal

Physicochemical Properties of Dehydrated and Rehydrated Red Gram and green Gram dhal presented in Table 2 revealed that, red gram dhal samples retain its physical properties after rehydration as no lumps and brokens were found in all samples whereas rehydrated samples of green gram dhal who has soaked for more than 60 min prior to cooking found few lumps and brokens in it. So it could be concluded that soaking prior to cooking results in more moisture gain and this leads to increase in drying time. Unlike rice, pre soaking has positive effect on rehydration ratio of dhal. Similar findings were reported by Ghadge

et al.(2008). On the basis of above findings, the red gram dhal sample soaked for 60 min and green gram dhal sample soaked for 30 min were chosen for the formulation of Vegetable Khichadi Mix because these two samples stood best among others in terms of rehydration characteristics and appearance.

Table 3 shows the physicochemical properties of dehydrated and rehydrated vegetables. All vegetables were subjected to steam blanching to retain water soluble nutrients and colour. All vegetables become rehydrated within 5 minutes and almost doubled in weight after rehydration. Table 4 highlights the cooking characteristics of control khichadi and Ready to cook vegetable Khichadi Mix samples. All the samples were attended the final temperature 88°C while rehydrating. The control sample which was prepared by rice and green gram dhal required 20 min to cook whereas in contrast to those experimental samples cooked in 5 minutes. A significant reduction in cooking time was found with almost four to five time more weight after rehydration.

Table 3: Physicochemical Properties of dehydrated and rehydrated Vegetables

Vegetable	Blanching Time	Drying Time (min)	Moisture in dried sample (%)	Rehydration Time	Rehydration Ratio
Cauliflower	12	6	5.98	5	1.8
French Beans	15	6	5.00	4	2.0
Green Peas	15	7	6.01	4	2.0
Carrot	08	6	4.92	4	1.5

Table 4: Cooking Characteristics of Rehydrated Vegetable Khichadi Mix

Sample Code	Rehydration Temperature (°C)	Rehydration time (min)	Rehydration Ratio
Control (60:30)	88	20	3.5
VKM F1 (50:30:20)	88	5	4.5
VKM F2 (60:20:20)	88	5	4.7
VKM F3 (70:10:20)	88	5	5.0

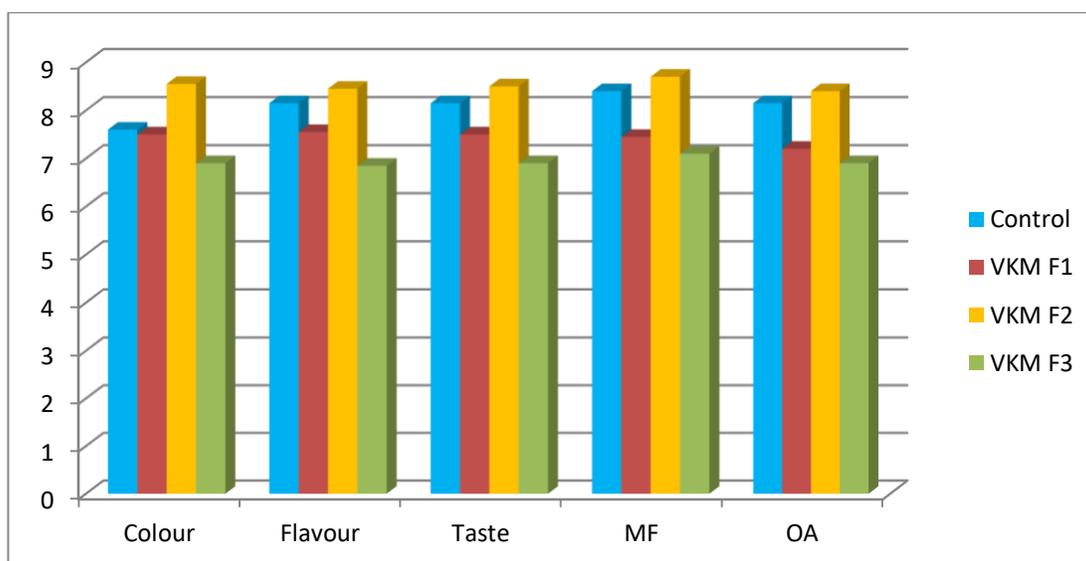
VKM- Vegetable Khichadi Mix

Sensory characterization of RTC Vegetable Khichadi Mix based on colour, flavor, taste, mouthfeel and overall acceptability is shown in Table 5 and graphically depicted in Figure 1. The above measured mean values are used to plot the responses. The formulated samples were evaluated by 20 semi trained panel members. It is clear from the total score and chart (Fig. 1) that the formulated product VKM F2 gained higher score among three mixtures. Sample F2 also scored best with colour, mouthfeel and overall acceptability. Hence it was chosen and subjected to chemical analysis.

Table 5: Sensory Evaluation of RTC Vegetable Khichadi Mix

Sample Code	Color	Flavor	Taste	Mouthfeel	Overall acceptability	Total Score (Out of 45)
Control	7.6 ± 0.503	8.15 ± 0.366	8.15 ± 0.366	8.4 ± 0.503	8.15 ± 0.366	40.45 ± 0.999
VKM F1	7.5 ± 0.513	7.55 ± 0.510	7.5 ± 0.513	7.45 ± 0.510	7.2 ± 0.410	37.2 ± 0.834
VKM F2	8.55 ± 0.510	8.45 ± 0.510	8.5 ± 0.513	8.7 ± 0.470	8.4 ± 0.503	42.6 ± 0.940
VKM F3	6.9 ± 0.553	6.85 ± 0.587	6.9 ± 0.447	7.1 ± 0.447	6.9 ± 0.308	34.65 ± 1.182

Mean ± SD with a difference significantly ($0 \leq 0.5$)

**Figure 1: Graphical representation of Control vs. RTC VKM samples****Table 6: Chemical Analysis (VKM F2)**

Parameters	Unit	Values
Proximate Analysis		
Moisture	(%)	6.57
Total Minerals	(%)	1.48
Crude Proteins	(%)	10.52
Crude Fat	(%)	2.16
Crude Fiber	(%)	2.21
Carbohydrates	(%)	77.79
Energy	K Cal	373.08
Other Analysis		
Vitamin C	Mg	1.22
Iron	Mg	13.27

The values belong to chemical analysis (sample F2) are tabulated in Table 6. The moisture content in Vegetable Khichadi Mix was 6.57 %. Total minerals, crude protein, crude fat and crude fiber content were found to be 1.48 %, 10.52 %, 2.16 % and 2.21 % respectively. Vegetable Khichadi Mix provides 373.08 Kcal of energy and 77.79 % carbohydrates per 100 gm. This

product also gives 1.22 mg Vitamin C and 13.27 mg of iron. This chemical composition revealed that the developed product contain good amount of energy, proteins and iron..

CONCLUSION

Among the three formulations made of Vegetable khichadi mix, the formulation with ratio of 60:20:20 rice, dhal and vegetables respectively were ranked highest in sensory evaluation. Cooking time was 5 minutes as compared to traditional rice dhal khichadi which requires 20 minutes to cook. Hence, cooking time was reduced by 75 percent. The shelf life of this product is almost for months. Instant Khichadi Mix is rich in energy, protein and iron. Instant Khichadi Mix can be used as means of supplementary nutrition for beneficiaries of ICDS, as it is healthy, nutritious food and culturally appropriate. Future study is to scale up parameters for microwave drying.

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