

Assessment of acceptability of black wheat flour products and factors affecting it among Anganwadi beneficiaries and workers: A mixed-method prospective observational study

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ABSTRACT

Introduction: Malnutrition is very common in India and black wheat might be an acceptable solution to this problem. The aim of the study was to assess acceptability of black wheat flour products and factors affecting it among Anganwadi beneficiaries and workers. **Materials and Methods:** This was a mixed-method prospective observational study. All the family members enrolled for supplementary nutrition and Anganwadi workers/helpers of three randomly selected Anganwadi centers were taken in the study. For qualitative data, in-depth interview was done, and for quantitative data, 9-point hedonic scale was administered. Braun and Clarke's six-phase data analysis framework was used for qualitative data. **Results:** A total of 16 pregnant females, 14 lactating females, 16 children, 2 Anganwadi workers, and 3 Anganwadi helpers participated in the study. Thematic analysis of the data revealed five significant themes. It included characteristics of black wheat flour, the process of making the product (experience of making the product), family acceptability, availability, and hygiene. Participants expressed that the black color appearance is one of the negative influencers in the acceptability of black wheat flour. Most of the participants liked the taste as well as the texture. However, kneading, rolling, and puffing were more challenging than traditional wheat flour. On the hedonic scale, the mean rank of acceptability is lowest for color (3.03), followed by puffing (3.49) and highest for texture (4.87) and taste (4.60). **Conclusion:** Our study results revealed that black wheat is acceptable to the Anganwadi beneficiaries and workers.

Keywords: Acceptability, Anganwadi beneficiaries, Anganwadi workers, black wheat flour, malnutrition

Introduction

Pregnancy, lactation, and early childhood are the most crucial periods of growth and development. Apart from calories, protein and micronutrients are also important for this intense period of growth and development.^[1,2] Global nutrition report 2021 reported that the Indian diet is poor in micronutrients and India

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is struggling with the global nutrition target of prevention of childhood wasting and anemia.^[3]

The National Family Health Survey of India (NFHS-5) documented that 51.7% of pregnant women and 71.1% of children aged 6-59 months were anemic (Hb <11.0 g/dl) in Punjab. The prevalence of stunting and wasting was 24.5% and 10.6%, respectively, in children under 5 years of age in Punjab.^[4]

The shift from consuming the traditional white wheat (*Triticum aestivum*) flour approach to consuming black wheat flour, which has more nutritional value, and its antioxidant property helps in the prevention of diabetes and cardiovascular diseases such as inflammation, obesity, cancer, and aging.^[5] Black wheat contains high-quality proteins, iron, zinc, and essential amino acids, particularly the content linoleic and linolenic acids.^[6-8] Normal wheat with supplemental anthocyanin (a phenolic compound) content results in colored wheat (purple, blue, and black), which has been developed by the National Agri-food Biotechnology Institute (NABI), Mohali, Punjab, after 7 years of research.^[6-8]

A mismatch between enhanced demands for protein, energy, and micronutrients and improper replenishment during pregnancy, lactation, and early childhood leads to increased nutritional vulnerabilities including malnutrition among mothers as well as their infants and young children.^[1,2] In this context, the need for highly nutritive food items, which are locally acceptable as well as available, cannot be denied.

The Integrated Child Development Scheme (ICDS) is India's world's largest early childhood development program. ICDS scheme aims to reach, all children aged less than 6 years, pregnant and lactating females in rural areas and urban slums. It provides supplementary nutrition, growth monitoring, and nutrition education, so Anganwadi was the most suitable place to know the acceptability of black wheat flour.^[9]

As undernutrition and micronutrient deficiency are very prevalent in India and primary care physician deals with this problem every day, black wheat can be the possible solution in the prevention and treatment of this, very important public health problem. Black wheat is a novel solution at the primary care level, and no community-based study has been done to explore the acceptability of black wheat. Based on the above background, the present mixed-method study was undertaken to assess the acceptability of black wheat flour products and factors affecting it among Anganwadi beneficiaries and workers.

Materials and Methods

Study design

This was a mixed-method, prospective observational study. The study adopted mixed-method approach, i.e. both qualitative and quantitative. For qualitative data, in-depth interview was done, and for quantitative data, a pretested, valid, and structured

questionnaire was filled out. The experience of black wheat flour was compared with the traditional white wheat flour.

The study was approved by Dr. B. R. Ambedkar State Institute of Medical Sciences, Mohali, Punjab Ethics Board (AIMS/IEC/39/2022 dated 3.11.2022). Informed written consent was taken from all participants. In the case of minors (children <6 years), parents/grandparents provided written informed consent, and in the case of illiterate, informed consent was verbally narrated in their understandable language in the presence of their husbands and both participant and their husbands signed the informed consent form (all illiterate females were capable of doing signature in Hindi/Punjabi). All methods were carried out in accordance with relevant guidelines and the Declaration of Helsinki.

Study sample

The present study was carried out in primary health center (PHC) Bhoogarh, district Mohali, Punjab, a rural field practice area of Dr B.R Ambedkar State Institute of Medical Science, Mohali, and urban slum area of district Mohali, Punjab. The total population of PHC Bhoogarh was 51,000, and urban slum was 14,500. The sample was selected through three stages with random sampling [Figure 1]. In the first stage, two rural subcenters out of a total 21 subcenter of PHC Bhoogarh were selected randomly through a lottery method. In the second stage, one Anganwadi was selected randomly from each subcenter. A list

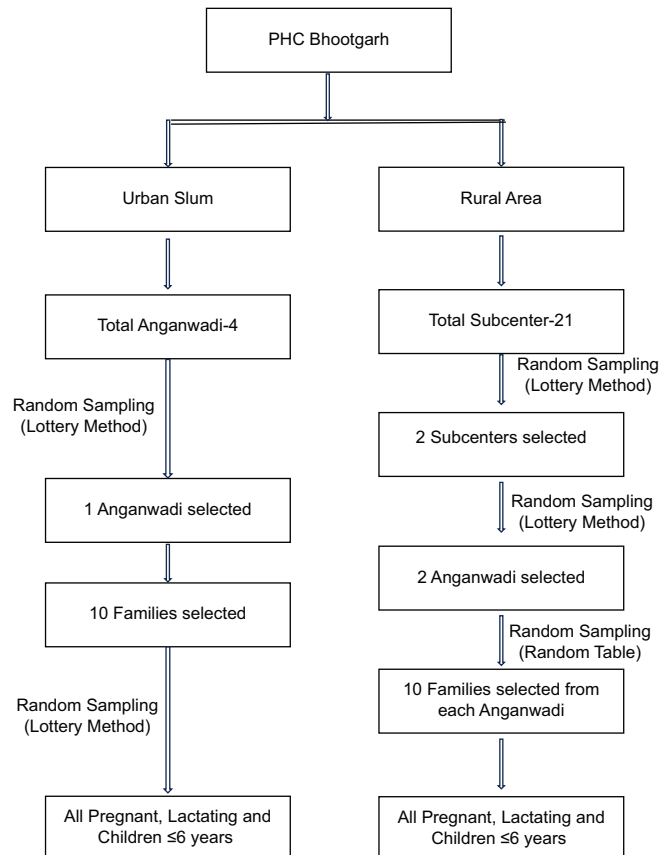


Figure 1: Flow diagram of the study

of all beneficiaries from each Anganwadi center was prepared. In the third stage, ten families from each Anganwadi were selected randomly by a random number table. To ensure the national representation of the sample in terms of rural and urban populations (70 rural: 30 urban), two subcenters were selected from the rural area and one subcenter was selected from the urban slum.^[10] Anganwadi workers and helpers of all the three Anganwadis were also included.

Methodology

All the family members (children aged less than 6 years, pregnant and lactating females) enrolled for supplementary nutrition in the selected family were included in the study. Beneficiaries who had not given consent, suffering from chronic disease, and severely malnourished beneficiaries were excluded from the study.

A three-stage method was followed: First, a semi-structured interview schedule was developed to explore the expectations of the beneficiaries and Anganwadi workers (NA, MN, AA, and BB). To minimize the possibility of asking leading questions, the final draft of the questionnaire was sent to a total of five experts for review. The experts included faculty members from two different institutions who were: two pediatricians, two community medicine specialists, one nutritionist, and one psychiatrist. The feedback given by the experts was again discussed amongst researchers, and appropriate changes were made (Supplementary Material File 1).

In the second stage, all selected families were called at their respective Anganwadi centers by ASHA worker/Anganwadi helper on a suitable day. A brief introduction about the project was given and the benefits of black wheat were delivered to them. Written informed consent was taken from all beneficiaries, and in the case of minors, consent was obtained from the mother/grandmother. In the third stage, a suitable day was given to them for the distribution of black wheat flour. On the second visit, 2 kg black wheat flour/participant was distributed. Participants were asked to use flour within a week. On the third visit (which was within 10-14 days after the distribution of flour), in-depth interviews were taken from the beneficiaries, and the case of minor interview of the mother/grandmother was taken. Prompts and probes were used like “please give examples,” “can you expand further,” etc. Three investigators (AN, AA, and NG) conducted all interviews. Each interview lasted 30–40 minutes. Color, stickiness, taste, roll out, puffing, taste, tearing, and texture were assessed based on a 9-point hedonic scale. The participants made product from black wheat flour, and they were free to make any product like chapati, paratha, etc., from black wheat flour.

Statistical analysis

All data were de-identified prior to analysis. Braun and Clarke’s six-phase data analysis framework was used for qualitative data. It comprised of six steps: (1) Transcription and familiarization with data; (2) Generating initial codes; (3) Searching for themes; (4) Reviewing themes; (5) Defining and naming themes,

and (6) Producing the report.^[11] Inductive, i.e., the data-guided identification of themes without a priori hypothesis approach was used for analysis.^[12]

Quantitative data were analyzed with SPSS version 20 (IBM Corp., Armonk, NY, USA). Percentages, means, and Friedmann two-way analysis were used to compare mean rank. The level of significance was fixed at <0.05.

Results

In the current study, 16 pregnant females and 14 lactating females were interviewed. In addition to females, black wheat flour was provided to 16 children and their experience with black wheat flour was asked from their mother only. The description of characteristics of participants and their children are depicted in Table 1. Two Anganwadi workers and three Anganwadi helpers were also interviewed. One Anganwadi worker was on leave throughout the study period. The education of Anganwadi workers is above matric, and Anganwadi helpers were educated up to primary level. The duration of providing services was >10 years.

The product made from black wheat flour was mainly chapati, pakode (1 participant), and paratha, but all participant tasted chapati. Thematic analysis of the data revealed five significant themes [Table 2]. These themes and subthemes are further discussed in detail.

Table 1: Characteristics of the participants (n=51)

| Variables | Frequency | % |
|---------------------------------------|-----------|-------|
| Pregnant/lactating females (30) | | |
| Age | | |
| 20-30 | 19 | 63.33 |
| 30-40 | 11 | 36.67 |
| Education | | |
| Illiterate | 5 | 16.7 |
| Primary | 9 | 30.0 |
| Up to High School | 15 | 50.0 |
| Graduate | 1 | 0.03 |
| Family Type | | |
| Nuclear | 09 | 0.30 |
| Joint | 21 | 0.70 |
| Duration of availing services | | |
| 1 year | 06 | 20.0 |
| 1-2 years | 10 | 33.3 |
| >2 years | 14 | 46.7 |
| Children ^[16] | | |
| Age | | |
| 2-4 years | 06 | 37.5 |
| 4-6 years | 10 | 62.5 |
| Sex | | |
| Male | 08 | 50 |
| Females | 08 | 50 |
| Anganwadi workers (2) and helpers (3) | | |
| Duration of the service | | |
| ≥10 to <15 years | 2 | 40 |
| ≥15 years | 3 | 60 |

Table 2: Thematic analysis of acceptability and factors influencing the acceptability of black wheat flour of all participants (n=51)

| Themes | Subthemes |
|---|---|
| Characteristics of black wheat flour products | Appearance Taste Texture |
| Process of making product | Kneading Rolling Puffing |
| Family acceptability | Children Other family members |
| Availability | As supplementary nutrition in anganwadi Free of cost |
| Hygiene | Clean and dry Well packed |

Characteristics of black wheat flour

The theme depicts that the taste, appearance, and texture of black wheat flour play a crucial role in the acceptability of black wheat flour.

The results related to this category can be subcategorized into following two categories:

Appearance

Participants expressed that the black color appearance is one of the negative influencers in the acceptability of black wheat flour. As one of the participants said:

I and my children did not like the roti, and did not feel like eating black colour roti (N8).

Caregivers asserted that the black color of the product has particular importance in the case of children.

When my children saw the colour of the roti they didn't even hold the roti and didn't eat it (N6).

Taste

Participants accepted that they did not use the black flour alone and they half to one-fourth mixed it with other flour (mainly white flour) or made stuffed paratha to increase the taste and mask the color. Most of the participants liked the taste.

I made roti stuffed with mooli (radish), it tasted like maize roti. Everybody liked it (N11).

My children liked the roti they eat all chapattis, they ate as much as they used to eat previously (N13).

Texture

Most participants said that the texture of the thick chapati made from black wheat flour was good as compared to thin chapati.

I made thin chapatis (of usual size) that got dry, but when I made thick chapatis or pakode then it was ok. But otherwise, I liked the chapati. (Anganwadi helper)

Process of making products

This theme represents the experience of participants while kneading, rolling, and puffing of black wheat flour compared to white wheat.

Kneading and rolling

Participants reported stickiness while kneading and rolling the black wheat flour compared to white wheat.

While kneading the flour, the flour got stick on my hands, I faced difficulty in kneading the flour and in rolling chapatis but chapatis were tasty (N12).

Puffing

Many participants told that chapati puffed less than the white wheat flour chapati, but the taste and other qualities were similar.

My all chapati puff fully from white wheat flour but chapatis from this black wheat didn't puff or puffed almost one-third to half as compared to normal wheat flour (N15, N21).

Family acceptability

Participants have expressed a wide range of concerns of approval from their family members.

Other family members

Participants have expressed concerns and approval of their family members about using black wheat flour.

When I and my children was eating chapati, my husband and mother-in-law said what are these black chapatis. Then I gave them, they ate and said it is tasty. Meals should be liked by all as all are important (N1, N15).

Children

Participants expressed that children are key persons who decide what should be cooked as they need both balance diet and taste.

My children liked it and ate all chapattis, but they asked why it is black then I told them it is because of chocolate. I was satisfied because be ate nutritious food without any tantrum (N25).

Availability

Many participants expressed that to use black wheat flour, decisions would be based on their financial status.

As supplementary nutrition in Anganwadi

The high cost of black wheat flour will discourage them to use it. But if it will be provided at Anganwadi free of cost, then they will use it.

If this flour will be provided in Anganwadi or in school then it will be very useful because we don't have so much money to buy it from market. It is useful and tasty also (N19, N5, N26).

Free of cost

The participants expressed that decision to use black wheat flour will be hindered by cost.

As you said that black flour is useful, but its cost is around double to triple as compared to normal wheat flour in market, so we cannot afford it. But we liked it, and we will use if it will be provided at Anganwadi (N22, Anganwadi workers).

Hygiene

The theme summarizes participants' expectations from the government and the providers of supplementary nutrition. Subthemes under this category are discussed below:

Clean and dry

Participants underscored that clean and dry flour is very important factor to use it.

Flour was good and tasty also if it will be provided in dry and clean condition the we will use it. It has taste and many useful properties also (N1, N29).

Well packed

The participants expected that the flour should be well packed with proper labeling.

The flour packing was very good, every ingredient was mentioned very clearly. Packing and labelling shows that it is good for health and well maintained. (N27, Anganwadi worker)

Table 3 illustrate the result of quantitative data analysis of various hedonic scale variables.

Acceptability mean rank of various hedonic scale variable varied from 3.03 to 4.87. The mean rank of acceptability is lowest for color (3.03) followed by puffing (3.49) and stickiness (3.51). The highest mean rank of acceptability was of texture (4.87) followed by taste (4.60).

Discussion

Wheat (*Triticum aestivum*) is one of the oldest, and it has been consumed for centuries as the staple food of India, which has a poor quality of protein and is deficient in iron and zinc.^[13] Black wheat came with good prospects to fight against one of the major challenging issue, i.e. protein energy malnutrition and iron deficiency.^[7,8] Before introducing black wheat at the state- or national-level discussion and taking service providers' and service beneficiaries' views have become apposite than ever.

The black wheat flour products characteristics: appearance, taste, and texture are very basic parameters for the acceptability of black wheat flour in the community. As people have a habit

Table 3: Comparisons of the mean rank of various Hedonic scale variables (n=35)*

| Variables | Mean rank | Significance |
|------------|-----------|-------------------------------|
| Color | 3.03 | Chi-square-26.135, P<0.001 |
| Stickiness | 3.51 | |
| Roll out | 3.91 | |
| Puffing | 3.49 | |
| Taste | 4.60 | |
| Tearing | 4.59 | |
| Texture | 4.87 | |

*Children were excluded from the study. *Only chapati was taken for uniformity

of making and seeing white flour chapatis, the black color of chapatis may give them a repulsive feeling. The participants overcame these problems by mixing it with white flour, but it will decrease black wheat nutritional value. The taste was said to be good or equally good to white wheat flour. According to Garg *et al.* 2022, black wheat has a low stickiness value, which means it has better baking properties; so black wheat can be better used for making bakery products.^[14]

According to the Kumari *et al.* 2020, biofortified black wheat has acceptable sensory parameters, good taste, and soft texture of chapatti as it is rich in anthocyanins and phenolic compounds that impart positive physiological effects in humans. Although results are like Kumari's but black wheat alone was not acceptable to beneficiaries.^[15]

The process of making a product is another important category flagged by participants. The participants faced more problems in kneading, rolling, and puffing as compared to white wheat flour. The stickiness while kneading the flour can negatively impact the daily use of flour. During rolling, also stickiness was felt by many participants. These findings are not in line with a study conducted by Garg *et al.*, which showed higher dough extensibility in black wheat as compared to white wheat.^[14]

According to the Kumari *et al.*, higher water absorption was observed for black wheat chapattis as compared to wheat chapatti. Puffing was also higher in colored wheat chapattis.^[15,16] The study showed that black wheat chapattis had similar chapatti scores as observed in a wheat chapatti. But, in the present study as compared to white wheat flour, less puffiness of black wheat chapatis was observed by the participants.

Several participants asserted the need of family acceptability to use black wheat flour. The present study suggests that black wheat flour was acceptable to other family members also. The present study also suggests there is a need of liking and approval of black wheat flour in children as they are also important in making food-related choices.

Furthermore, participants have also expressed concern about the availability and price of black flour. The cost of black wheat flour varies in the market from Rps 200-400/kg. According to agricareer, the normal wheat price in the market

is 1800-1900 rupees/quintal (1quintal = 100 Kg) and the black wheat price is at least Rs 3500 per quintal.^[17] The black wheat price is almost double than white wheat price.

Discussing further participants' assertion that basic hygienic flour means clean, dry, and well-packed black wheat flour should be an integral part of the supply. The authors believe that meeting the expectations of participants is highly important in improving the use and satisfaction with supplementary nutrition. Black wheat has the potential to provide continuation of use and is likely to benefit the nutritional deficiency in vulnerable populations. This is very important for primary care physicians. Hence, further research is warranted in this area.

Limitations of the study

The study's main limitation is that a small number of participants were selected from a single primary health center in Punjab. As the participants made product from the black wheat flour, the uniformity of the process is not reliable, but as study was done in community, this type of observation was expected, and moreover, authors compared their experience with white wheat flour to overcome this limitation. Experience of children was taken from their mothers, so the children participated indirectly in the study.

Finally, due to the observational nature of the study and the limited availability of black wheat flour, the chances of subjective bias cannot be overlooked. The cohort study with the laboratory measurement of nutritional elements (iron, zn, and calcium), and physical and functional properties needed to be done at the community level along with the standardization of the product.

Conclusion

In a nutshell, it can be concluded that black wheat is acceptable in the participants but with addition to white wheat flour. The black color of wheat, stickiness, and increased cost are negative influencers to use the black wheat flour. The addition of white wheat flour in ratio of one-third to half can help in the initial phase of the introduction of black wheat flour. The approval by all family members and clean and well-packed flour had a positive influence on the acceptability of flour.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Material File 1

Participants' Information Sheet

Title of the Study/Project: Assessment of acceptability of black wheat flour products and factors affecting it among Anganwadi beneficiaries and workers in Punjab, India: A mixed-method prospective observational study

Investigator: Dr. Anuradha Nadda (Ph. XXXXXXXX)

Introduction: The investigator is conducting a research project to explore the acceptability of black wheat flour products and the factors affecting it among Anganwadi beneficiaries and workers. You are invited to participate in this research project. Before you decide whether you want to be in the study, it is important that you understand the project and ask any questions you might have. As you go through the information about the study and have any questions, you can ask the investigator about the same.

Purpose of the research: The purpose of this research study is to explore the acceptability of black wheat flour products and the factors affecting it.

Participant selection: You are being invited to be in the research because you have been given informed written consent and are ready to consume the black wheat flour.

Voluntary participation: Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you decide not to participate at any stage of the study, you can choose and this will not affect you in any way.

Procedures and protocol: The study will be conducted in the form of a detailed interview. You will be asked a few questions regarding your experience with the black wheat flour. There are no right or wrong answers to these questions and you can choose not to answer any questions if you are not comfortable. The interview will be recorded by the researcher in order to understand and reflect on your views, experiences, and opinions. The researcher will also be taking notes during the information so that no important information is missed. Based on the interviews, the researcher will then decipher the factors, which can influence the acceptability of the black wheat flours in the community.

Risks and benefits: The participation is likely to not pose any risk to you. The information obtained can be analyzed in order to take steps to improve the acceptability of black wheat flour or its delivery-related challenges.

Confidentiality: The information that we collect from this research project will be kept confidential. Any information connecting your name with your responses to this interview will be kept by the researchers in a locked file. Your name will not be shared with anyone who is not part of the research team that is directly involved with this project. The forms and computer files that contain your responses to the interview and other information about you that we will use for research purposes will not mention your name and will contain only a number. No report will ever be made about your individual responses.

Sharing the results: The information that comes from this study may be published so that others can learn from our research, but no names or individually identifying information will be included in any such publications.

Right to refuse or withdraw: You do not have to take part in the research if you do not wish to do so. You may also stop participating in the research at any time you choose. It is your choice.

Interview Guide

I am Dr. Anuradha Nadda and I am conducting a research study to assess the acceptability of black wheat flour products and the factors affecting it. For this, you will be asked a few questions regarding the factors that can influence the acceptability of black wheat flour and delivery challenges. There are no right or wrong answers to these questions, and you can choose not to answer any questions if you are not comfortable. The interview will be recorded by the researcher in order to understand and reflect on your views, experiences, and opinions. The researcher will also be taking notes during the information so that no important information is missed. Based on the interviews, the researcher will then decipher the common factors, which can influence the acceptability of black wheat flour or its delivery-related challenges. This information is anonymous and will be kept confidential. All information will be used only for project work and eventually published will not identify you.

Questionnaire Section-I

Place: Date:

Name: Education:

Type of Family: Nuclear/Joint/3Generation Age/-

Duration of Availing Services:

Do your kids are also beneficiaries of Anganwadi: Y/N

How many Kids (if Yes):

Name: Age/Sex:

Anganwadi workers/Helper Name:

Section-II

Have you consumed your all-black wheat flour: YES/NO

Sample Trigger Questions

- **For all participants**
 - Can you tell me why you agreed to consume black wheat flour?
 - Can you please elaborate on your experience of using black wheat flour?
Can you describe it with an example?
Can you explain further about the visual appeal and taste of the product prepared
 - Can you please explain the reaction and liking of your kids about black wheat flour products? Please Give an example like they finished their meal, etc.
 - What might be the challenges/benefits of processing/preparing products from the black wheat flour?
Please tell me with example
 - What are your expectations from the producer/distributors of the black wheat flour? Please explain.
 - Do you want to use it again or not? And why?
- **For Anganwadi workers and helpers only**
 - Do you think free of cost or less price is the most important reason for the consumption of black wheat flour?
 - How do you think your communities' culture (general beliefs, values, assumptions that people embrace) will affect consumption of black wheat flour products?
 - a. Can you describe an example that highlights this?

Section-III

Can you please rate the black wheat flour on the following parameters?

| Parameters | Black wheat | Remarks (if any) |
|-----------------------------|-------------|------------------|
| Color | | |
| Stickiness (while kneading) | | |
| Roll out easy | | |
| Puffing Height | | |
| Taste | | |
| Tearing strength | | |
| Texture | | |
| Overall acceptability | | |

Hedonic Scale

| Expression | Points to be assigned |
|----------------------------|-----------------------|
| Liked extremely | 9 |
| Liked very much | 8 |
| Liked moderately | 7 |
| Liked slightly | 6 |
| Neither liked nor disliked | 5 |
| Disliked slightly | 4 |
| Disliked moderately | 3 |
| Disliked very much | 2 |
| Disliked extremely | 1 |