SENSORY AND NUTRITIONAL PROPERTIES OF A NOVEL COOKED EXTRUDED LENTILS ANALOG

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ABSTRACT

The main objective of this research was to utilize extrusion processing for developing a wheat- and soy-based “lentil analog” product. The sensory properties and the nutrient content of this product were studied. Lentil analog products using six formulations were produced using a pilot-scale twin screw extruder. Descriptive sensory analysis of prepared products showed that all extruded treatments were similar to each other, but different from the natural lentil control. Treatments with soy: wheat ratios of 50:50 in the presence of lecithin, 60:40 and 70:30 are higher in descriptive attributes of beany flavor, particles/residuals and firmness compared with the control. Consumer acceptability testing (9-point hedonic scale) indicated that there were no significant differences (P < 0.05) in acceptability among the selected treatments and the lentil control sample. Lentil analog can be used as a substitute for regular lentils that is increasingly a costly commodity.

PRACTICAL APPLICATIONS

A novel extruded lentil analog product with high consumer acceptability was produced, which can provide a low-cost, high-protein diet and rich in essential vitamin and minerals. This product can be supplied to the general population in countries of South Asia and the Middle-East, as a substitute for regular lentils.

INTRODUCTION

Lentils occupy an important role in human nutrition all over the world especially in the developing countries because of its nutrient content (Khan et al. 1987; Sharma et al. 1989; Achinewhu and Akah 2003). Lentils can be consumed in different forms such as a thick soup made from the whole grain or split pulse. Lentil consumption is increasing rapidly in the world. Also, the total lentils production has remained constant during the past two decades, whereas the population has increased remarkably during the same period. As a result of this, the per capita availability of food legumes has significantly declined and the cost has risen (Solanki et al. 1999). However, the presence of fermentable oligosaccharides in the lentils composition causes flatulence because of the action of anaerobic intestinal microflora on these oligosaccharides. This flatulence implies an obvious discomfort and is a major impediment to greater consumption of lentils (Dhindsa et al. 1985). Therefore, it appears there would be a demand for a lentil analog that contains low fermentable oligosaccharides, and that is acceptable to the consumer.

Extrusion cooking is a process in which starchy or proteinaceous foods can be changed into a viscous, plastic like dough and cooked before being forced through a die under moistened conditions (Riaz 2000). Many changes can happen during the extrusion process such as: starch gelatinization, protein denaturation, native enzymes inactivation, toxic substances destruction and declining of microbial counts (Colonna and Mercier 1983). Extrusion cooking and puffing of cereals is widely practiced (Onwulata et al. 1998). Extrusion cooking produces different types of food products from inexpensive raw materials with minimum processing time. Also, extrusion can be used to improve the
bioavailability of the most nutrients in the food products. Cheng and Hardy (2003) found that the extrusion has the ability to increase the apparent digestibility coefficients of crude protein and some minerals of soy flour. Also, Barrows et al. (2007) found that the higher temperature in the extruder significantly improved the apparent digestibility coefficient for organic matter, energy and carbohydrates. Moreover, most of these snacks can be produced by extrusion technology (Onwulata et al. 2001; Obatolu 2002; Ibanog˘lu et al. 2006; Smitha and Hardacre 2011; Saeleaw et al. 2012).

A complementary protein product can be obtained from mixing cereals and legumes together to obtain a good source of protein because of their deficiencies in certain amino acids (Potter 1986; Claughton and Pearce 1989; Rababah et al. 2006).

Abughoush et al. (2014) evaluated chemical and physical properties of all treatments of the lentil analog and the natural lentil (control). It was observed that this lentil (control) was characterized with high firmness. Also, texture analysis of other treatments revealed that the products formulated with 60:40 and 70:30 soy : wheat ratios exhibited a significantly higher \((P < 0.05)\) hardness, adhesiveness and lower springiness compared with all other treatments and with less hardness than the control. The chemical analysis of the treatments indicated that the lentil (control) is formed from: 24.83% protein and 2.56% ash, while the lentil analog contained significantly higher protein (32%) and ash (4.9%). Yet, no significant differences in the fat and fiber were observed. There were insignificant differences in the moisture content (MC) among all the treatments. The MC of all the treatments ranged between 9.3 and 10.0%. The lentil (control) had significantly the lowest water holding capacity (WHC) compared with all other treatments. Also, there were significant differences at \((P < 0.05)\) in the WHC among some different treatments. Therefore, it is expected that this variation will have an effect on all the physical, chemical and sensory properties of the extruded products. More information regarding the physical and the chemical properties of this new product can be obtained from our previous study (Abughoush et al. 2014).

The objectives of this study were to develop a value-added extruded product that is similar in its properties to lentils in terms of nutritional and sensory properties, and that is able to be prepared within a short time.

**MATERIALS AND METHODS**

**Materials**

Soft red winter whole wheat flour (Graham flour) was obtained form cereal food processor (Kansas city), and the soy flour was obtained from Honeysole, USA. The following materials were generously donated by their respective company: soy lecithin (ADM, Decatur, IL); methyl cellulose gum (Belcamp, MD); Bounus Blend multivitamins (Caravan Ingredients, Kansas City, KS).

**Formulations**

Six different extruded treatments were formulated. The extruded products were based on soy flour (as a good source of protein) and wheat flour. The amount of the protein, fat, fiber and ash in each formulation was approximated to be the same amount or higher than lentils. Different binders and emulsifiers were used to improve the quality and the sensory properties of the final products. These binders were carbohydrate or protein polymers that function as emulsifiers, texturizers, and oil and water binding agents as shown in Table 1.

**Extrusion Processing for Lentil Analog Food**

A pilot-scale twin screw extruder (model TX-52, Wenger Manufacturing, Inc., Sabetha, KS), with screw of

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**TABLE 1. FORMULATIONS OF THE DIFFERENT LENTIL ANALOG PRODUCTS**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>Treatment 5</th>
<th>Treatment 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy flour (defatted)</td>
<td>49%</td>
<td>49%</td>
<td>49%</td>
<td>49.44%</td>
<td>59.44%</td>
<td>69.44%</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>49%</td>
<td>49%</td>
<td>49%</td>
<td>49.44%</td>
<td>39.44%</td>
<td>29.44%</td>
</tr>
<tr>
<td>Salt</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Monoglyceride</td>
<td>0.88%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hydroxypropylmethylcellulose</td>
<td>0</td>
<td>0.88%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lecithin</td>
<td>0</td>
<td>0</td>
<td>0.88%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vitamins</td>
<td>0.12%</td>
<td>0.12%</td>
<td>0.12%</td>
<td>0.12%</td>
<td>0.12%</td>
<td>0.12%</td>
</tr>
</tbody>
</table>

* *50% soy + 50% wheat and monoglyceride “SW(50:50)M;” 50% soy + 50% wheat and methyl cellulose gum “SW (50:50) G;” 50% soy + 50% wheat and lecithin “SW (50:50) L;” 50% soy + 50% wheat “SW (50:50);” 60% soy + 40% wheat “SW (60:40);” 70% soy + 30% wheat “SW (70:30).”*
medium-shear screw profile (Fig. 1) and circular die opening of 0.125" with 18 holes, was used to process all materials. Before extrusion runs, the extruder was calibrated to ensure that selected feed rate and water injection rates were accurate. With the screw speed fixed at 314–318 rpm, the treatment blends were each extruded at in-barrel MC of 21 and 24% (wet basis). The barrel temperature profile is also shown in Fig. 1. The lentil analog product was cut immediately after exiting the extruder die with a face-mounted rotary cutter turning at 1,940 rpm. Extruder conditions were allowed to stabilize for approximately 10 min before samples and process data were collected for 3–5 min for each treatment. Extrudates were subsequently dried at 180°C with a double-pass dryer/cooler (series 4800, Wenger Manufacturing, Inc.) adjusted for 15 min retention time (7.5 min each for the top and bottom belts). Cooling was accomplished at room temperature, with a 5-min retention time on the cooling belt.

**Sensory Test**

**Quantitative Descriptive Analysis.** The objectives of this evaluation were to profile six prototypes of extruded grain and compare them with a sample of control. Also, to select the three test samples closest to the control for consumer testing. A five-member highly trained descriptive panel profiled six samples of extruded grain and one sample of lentils. Products were prepared according to a standard procedure, which was found after several preliminary studies (Meilgaard et al. 2006). Attributes of the samples were identified and the intensities were quantified, utilizing a 15-point scale with 0.5 increments (0.0 = none; 0.5–5.0 = slight; 5.5–10.0 = moderate; 10.5–15.0 = extreme). Samples were presented monadically and coded with random three-digit numbers. Three replications of each sample were evaluated. Data were collected using Compusense® Inc. (West Guelph, ON, Canada). References for each attribute were used to calibrate the measurements. Attribute definition and references sheet can be found in Appendix 1.

**Consumer Acceptance Test**

Sensory evaluation of lentil analog product was conducted to determine acceptability of the product. A total of 51 consumers were selected from international students at Kansas State University on the basis of their willingness to participate and who frequently consume lentil (Indian subcontinents and Middle-East countries) of both genders (25 women and 26 men). Panelist ages ranged from 20 to 60 years old. All panelists were prescreened for food allergies and for how frequently they consume lentil. Each panelist evaluated three samples of lentil analog (These three analogs were T3, T5 and T6, which were selected in the Quantitative Descriptive Analysis [QDA] test.) in addition to the control during the session. Samples were presented monadically with random order and coded with random three-digit numbers. Distilled water and unsalted crackers were given along with the samples (Meilgaard et al. 2006). Panelists were instructed to cleanse the mouth before tasting each sample. Panelists were asked to score extrudates lentil analog and lentil for overall acceptability, general appearance, color, flavor (aroma and taste) and mouthfeel (texture) on a 9-point scale, where 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; and 1 = dislike extremely.

**Nutrient Content**

The nutrient content of the selected treatments (T3, T5 and T6 in addition to the control) which were selected after the

![FIG. 1. A PILOT SCALE TWIN SCREW EXTRUDER PROPERTIES WITH SCREW OF MEDIUM-SHEAR SCREW PROFILE](image)
QDA was determined. The moisture, protein, fat, fiber and ash content of samples were determined at the Analytical Services Laboratory of Kansas State University (AOAC 1995). The vitamin A, folate, B12 and iron content of treatments T3 and T6, representative of two different ratios of wheat: soy before and after extrusion, were determined at Meddallion Labs (Minneapolis, MN).

**Nutrition Labeling**

The nutrient content of the final wheat and soy lentil analog for the different treatments/serving size was determined using the Genesis R&D labeling program (ESHA Research, Salem, OR). The serving size used for nutrition labeling was for lentil analog meant to compete in stores. All ingredients for every treatment were entered into the Genesis program and the MC adjusted to reflect the values obtained earlier. Final nutritional analysis statements were used to determine allowable claims for the products.

**Statistics Analysis**

Three replications were performed on six different treatments in addition to the control. Treatments were compared for their sensory characteristics following a one-way complete randomized design. The analysis of variance (ANOVA) and means comparison were conducted by the general linear model (Proc GLM) and ANOVA (Proc ANOVA) procedures with Statistical Analysis System software (version 8.2, SAS Institute, Inc., Cary, NC). Comparisons among treatments were analyzed by Tukey’s studentized range honest significant difference test (HSD), with a significance level at \( P < 0.05 \).

**RESULTS AND DISCUSSION**

**QDA**

Flavor profiles show that test samples are similar to each other and different from the lentil control as can be seen in Table 2. The lentil control was mostly characterized by black pepper, beany, particles/residuals and firmness attributes. Even though all samples are similar to each other and different from the control, it was recommended that the samples T3, T5 and T6 can be used further for consumer testing. These samples seem to be higher in beany, particles/residuals, and firmness attributes, which are also seen in the lentil control sample as determined using the principle component analysis (PCA). In PCA, where interpretation of loading plots is the main objective, it is important to find which components are relevant and which variables are significant on the components (Westad et al. 2003). PCA as shown in Fig. 2 includes all samples and attributes evaluated in this study. The first two principal components explain 88% of the total variability between samples. This PCA was conducted on average values and the correlation matrix was used. These samples seem to be higher in beany, particles/residuals, and firmness attributes, which are also seen in the lentil control sample as determined using the principle component analysis (PCA). In PCA, where interpretation of loading plots is the main objective, it is important to find which components are relevant and which variables are significant on the components (Westad et al. 2003). PCA as shown in Fig. 2 includes all samples and attributes evaluated in this study. The first two principal components explain 88% of the total variability between samples. This PCA was conducted on average values and the correlation matrix was used. This analysis shows that all test samples are different from the control. The control has usually higher intensities of black pepper, beany, particles/residuals and firmness attributes. Because of the moderate difference between the control and test samples, a second PCA was conducted (Fig. 3). The control sample and the black pepper attribute

<table>
<thead>
<tr>
<th>TABLE 2. FLAVOR PROFILE ANALYSIS OF THE QUANTITATIVE DESCRIPTIVE ANALYSIS TEST FOR DIFFERENT TREATMENTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments properties</td>
</tr>
<tr>
<td>Adhesiveness to lips</td>
</tr>
<tr>
<td>Firmness</td>
</tr>
<tr>
<td>Adhesiveness grain to grain</td>
</tr>
<tr>
<td>Cohesiveness of mass</td>
</tr>
<tr>
<td>Particles/residuals</td>
</tr>
<tr>
<td>Tooth packing</td>
</tr>
<tr>
<td>Starchy mouth coating</td>
</tr>
<tr>
<td>Grain</td>
</tr>
<tr>
<td>Beany</td>
</tr>
<tr>
<td>Starch</td>
</tr>
<tr>
<td>Musty/dusty</td>
</tr>
<tr>
<td>Black pepper</td>
</tr>
<tr>
<td>Overall sweetness</td>
</tr>
<tr>
<td>Sweet</td>
</tr>
<tr>
<td>Salty</td>
</tr>
<tr>
<td>Bitter</td>
</tr>
</tbody>
</table>

* T1:50% soy + 50% wheat and monoglyceride “SW(50:50) M;” T2:50% soy + 50% wheat and methyl cellulose gum “SW (50:50) G;” T3:50% soy + 50% wheat and lecithin “SW (50:50) L;” T4:50% soy + 50% wheat “SW (50:50);” T5: 60% Soy + 40% wheat “SW (60:40);” T6: 70% soy + 30% wheat “SW (70:30).”

Means within the same row with different superscript letters are significantly different according to its P-value.
were excluded from the second analysis because black pepper was only present in the control sample. This PCA was also conducted on average values and the correlation matrix was used. Samples T3, T5 and T6 were recommended for consumer testing because they were closer to the control sample in the sense that they were usually higher in the beany, particles/residuals and firmness attributes, which were also present in the control sample. Even though some differences between test samples are noted, these differences were generally very small. From the previous results, it is recommended that increasing the black pepper flavor is recommended to have a better match to the lentil control sample.

A spider chart of attributes mean has been created to show the sensory differences evaluation of all the treatments (Fig. 4). It was noticed that the control had the highest beany flavor scores compared with all other treatments. While there were no significant differences among all the treatments and the control in overall acceptability, color and the mouthfeel after using Tukey’s test. The variations in the chemical and physical properties were revealed on the acceptance degree of the lentil analog (Abughoush et al. 2014).

**Consumer Acceptance**

Mean values for overall acceptability, appearance, flavor, color and mouthfeel (texture) are shown in Fig. 5. Consumers found that the lentil analog formulated with 60:40 and 70:30 soy : wheat and the control (Masoor) were significantly more favorable than the lentil analog formulated with 50:50 soy : wheat (which contains lecithin) in appearance and flavor. While there were no significant differences among all the treatments and the control in overall acceptability, color and the mouthfeel after using Tukey’s test. The variations in the chemical and physical properties were revealed on the acceptance degree of the lentil analog (Abughoush et al. 2014).

**Nutrient Content**

The nutrient content of the selected lentil analog products (T3, T5, T6 and the control) for protein, fat, fiber and ash is
shown in Table 3. Also, the micronutrient content of some vitamins (vitamin A, folate, B12) and minerals (iron) of the T3 and T6 lentil analog before and after extrusion is shown in Table 4. The lentil analog formulated with 70:30 soy : wheat (T6) had significantly the highest percentage of protein content compared with all other treatments as can be seen in Table 3. It can be noticed that as soy flour ratio increased the percentage of protein content also increased. This is due to the effect of soy flour, which is high in protein (Shogren et al. 2006). However, it can be concluded that all the lentil analog treatments were significantly higher than the control in the percentage of protein. There were no significant differences in the percentage of fat among all the treatments including the control except for T3 (50:50), which had the highest percentage of fat. This is expected as T3 formulated with lecithin, which is known as a good emulsifying agent and fat binders. The control had significantly the highest amount of percentage of fiber as compared with all other lentil analog treatments. The control had a higher amount of cellulose and other insoluble fibers, which could be responsible for keeping the grain integrity after cooking (Solanki et al. 1999; Pirman and Stibilj 2003). This variation affects some of the QDA results such as adhesiveness grain to grain, particles/residuals. The percentage of ash was significantly higher in the treatments that contain higher amount of soy (T5 and T6) as can be shown in Table 3.

The percentage of retinol was increased after extrusion for T3 by about 14% while it was decreased for T6 by about 12% as can be shown in Table 4. The extrusion conditions have the capability to destroy and decrease the availability of most vitamins and minerals (Tran et al. 2008). There were no significant differences in the retinol content between the T3 and T6 after the extrusion process. The extrusion process affects the folic acid content of both T3 and T6 in different direction and this could be due to the variation in the original composition between the two treatments. However, there were no significant differences in the folic acid content...
FIG. 4. SPIDER CHART OF ATTRIBUTES’ MEANS OF ALL THE TREATMENTS
Mean scores based on a 15-point scale with 0.5-point increments. T1: 50% soy + 50% wheat and monoglyceride “SW(50:50) M;” T2: 50% soy + 50% wheat and methyl cellulose gum “SW (50:50) G;” T3: 50% soy + 50% wheat and lecithin “SW (50:50) L;” T4: 50% soy + 50% wheat “SW (50:50);” T5: 60% soy + 40% wheat “SW (60:40);” T6: 70% soy + 30% wheat “SW (70:30).”

FIG. 5. COMPARISON OF CONSUMER ACCEPTANCE VALUES OF LENTIL ANALOG SELECTED TREATMENTS AND THE CONTROL (MASSOR)
Means with different superscripts indicate significant differences among all treatments (P < 0.05). T3: 50% soy + 50% wheat and lecithin “SW (50:50) L;” T5: 60% soy + 40% wheat “SW (60:40);” T6: 70% soy + 30% wheat “SW (70:30).”
between the T3 and T6 after the extrusion process. Vitamin B12, which is considered as one of the most important vitamins, is usually monitored during food processing. This vitamin was decreased significantly by 47 and 54% for the T3 and T6, respectively, after the extrusion as can be seen in Table 4. Iron is a very important mineral that we should consider during food processing. However, it was found that the iron availability was increased in the T3 by about 10% while it was not significantly affected in T6. The presence of lecithin may play a role in this result.

**Nutrition Labeling**

The nutritional content of the final wheat and soy lentil analog for the different treatments/serving size, i.e., calories, fat, sodium, carbohydrate, sugar, fiber and protein along with some vitamins and minerals A, C, calcium and iron are shown in Fig. 6. The serving size for the lentil analog is 100 g of all the three formulations. The total calories were decreased with increasing soy flour percentage in the formula. The total carbohydrate per serving of T3 was 54 g while it was 48 for the T6. Also, the total fat per serving of T3 was 2.5 g while it was 1.5 g for the T6. There were 340 cal per serving for the T3 while the T6 had 330 cal. The substitution of soy flour had a noticeable reduction in the caloric, carbohydrate and fat. Moreover, it can be noticed that as the soy flour increased, the percent protein content increased. The total protein per serving of T3 was 30 g while it was 37 g for the T6.

### CONCLUSIONS

It has been found that the descriptive sensory analysis (flavor profiles) show that test samples are similar to each other and different from the lentil control. The lentil control was mostly characterized by black pepper, beany, particles/residuals and firmness attributes. Moreover, even though all samples are similar to each other and different from the control, treatments T3, T5 and T6 (soy : wheat ratios of “50:50,” “60:40,” “70:30”) were recommended for consumer testing. These samples seem higher in beany, particles/residuals and firmness attributes, which are also seen in the lentil control sample.

Also, the consumer acceptability testing (9-point hedonic scale) indicated that there were no significant differences (P < 0.05) in acceptability among the selected treatments and the lentil control sample. However, further studies need to be done to improve the starchy mouthfeel, particles integrity, beany and black pepper flavor. Finally, this study proves that such lentil analog products can provide a low-cost, high-protein diet, which is also rich in essential vitamin and minerals, to the general population in countries of South Asia and the Middle-East, as a substitute for regular lentils that is increasingly a costly commodity.

### ACKNOWLEDGMENTS

Sincere thanks to the Jordanian–American Commission for Educational Exchange (The Binational Fulbright Commission) for supporting this work to increase mutual understanding between the people of the USA and people of Jordan. The authors thank Eric Maichel, Operations Manager, KSU Extrusion Center, for conducting all extrusion runs. We also thank Kaleb Beyer (Wenger Mfg.).
APPENDIX 1: GAIN STUDY

Stir sample first
Use ½ tsp of grain for the evaluation

TEXTURE

Adhesiveness To Lips: Wipe your lips before evaluation. Degree of stickiness of product to the upper lip.
Reference: American Beauty elbow macaroni = 7.0
Nishiki Sushi Rice (Short grain rice) = 9.0
Preparation: Macaroni: 113.5 g pasta in 2 qts of boiling water. Boil for 7 min.
Rice: 3/4 c of rice in 1.5 c of water. Cook covered for 20 min.

Firmness: The force required to compress (or bite through) cooked sample using the molar teeth.
Soft → Firm
Reference: Kraft Mild Cheddar Cheese = 4.5 (1/2 in. cube)
Nishiki Sushi Rice (short grain rice) = 6.0 (see above for preparation)
Hershey's Twizzlers = 8.0

Adhesiveness Grain to Grain: Rinse the mouth before evaluation. Degree to which the sample holds together when first placed in the mouth and manipulated with the tongue.
Reference: Jiffy Cornbread Muffin Mix = 4.0 (prepare according to package directions)
Nishiki Sushi Rice (short grain rice) = 6.0 (see above for preparation)

Cohesiveness Of Mass: Rinse the mouth before evaluation. The maximum degree to which the mass holds together during mastication. Measured after seven chews.
Reference: Nishiki Sushi Rice (short grain rice) = 6.0 (see above for preparation)
Kraft Mild Cheddar Cheese = 10.0 (1/2 in. cube)
AFTER SWALLOWING

Particles/Residuals: Rinse mouth before evaluating. Use four pieces of Cheerios. Amount of particles remaining in the mouth after swallowing. Masticate the sample on one side of the mouth, but avoid making an effort to contain the particles in a ball.
Reference: General Mills Cheerios = 3.0

Toothpacking: Degree to which product sticks or on/in surfaces of teeth. Rinse mouth before evaluating. Use four pieces of Cheerios.
Reference: General Mills Cheerios = 3.5

Starchy Mouthcoating: Degree to which sample mixes with saliva to form a starchy, pasty slurry that coats mouth surfaces. Use two pieces of elbow macaroni.
Reference: American Beauty elbow macaroni = 8.0 (see above for preparation)

FLAVOR

Grain: A general term used to describe the aromatics associated with grains such as corn, oats, and wheat. It is an overall grainy impression characterized as sweet, brown, sometimes dusty, and sometimes generic nutty.
Reference: American Beauty elbow macaroni (use two macaronis) = 4.5 (see above for preparation)
Spoon-size Post Shredded wheat = 7.0 (flavor)

Beany: A slightly brown, musty, slightly nutty and starchy flavor associated with cooked dried beans.
Reference: Bush’s best Pinto Beans = 7.5 (flavor)
Preparation: Drain and rinse with water before serving.

Starch: Aromatics associated with starch and starch-based ingredients such as grains or beans.
Reference: Bush’s Best Pinto Beans = 7.5 (see above for preparation)
American Beauty elbow macaroni = 9.0 (see above for preparation)

Musty/Dusty: Aromatics associated with dry grain and dry earth.
Reference: American Beauty elbow macaroni = 5.0 (see above for preparation)
Bush’s Best Pinto Beans = 3.0 (see above for preparation)

Black Pepper: Spicy, pungent, musty, and woody aromatics characteristic of ground black pepper.
Reference: McCormick Ground Black Pepper = 13.0 (aroma)
Preparation: Place ½ teaspoon of pepper in snifter, cover.

Overall Sweet: A sweet impression that may appear in the aroma and/or aromatics and/or taste.
Reference: Spoon-size Post Shredded wheat = 1.5
General Mills Wheaties = 3.0

Sweet: A fundamental taste factor of which sucrose is typical.
Reference: 1% Sucrose Solution = 1.0
2% Sucrose Solution = 2.0

Salty: The fundamental taste sensation of which sodium chloride is typical.
Reference: 0.15% Sodium Chloride Solution = 1.5
0.20% Sodium Chloride Solution = 2.5

Bitter: The fundamental taste factor of which caffeine or quinine is typical
Reference: 0.010% Caffeine Solution = 2.0
0.020% Caffeine Solution = 3.5
0.035% Caffeine Solution = 5.0

REFERENCES


