Sensory design of easy-to-chew food for elderly
-Ingredients and manufacturing conditions with focus on meat and carrot

literature review

Svenja Kaufmann

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Supervisors: Gunnar Hall and Karin Wendin

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1. Introduction

It is estimated that 30% of the elderly population are suffering from Dysphagia. The most common treatment of patients with eating- and swallowing disorders is to offer them texture modified diets. The aim of texture modified diets is to provide meals of a consistency that the patient can tolerate safely which provides adequate nutritional intake of calories, protein, vitamins and minerals. Actual intake of modified consistency diets is often reported to be poor. There are a number of problems associated with modified consistency diets and these include the consistency, appearance, nutritional adequacy and psychological effects to the patients. Regular meals that are minced in a mixer frequently do not meet nutritional requirements due to the addition of extra fluid during the production process that dilutes nutrition content. Even when these meals do meet nutritional requirements, their palatability is usually limited (Pace et al., 2002).

Since palatability is often limited tests to improve quality have been done. E.g. a survey at Northampton General Hospital showed that after introducing a shaped and thickened, more appetizing pureed diet on an a la carte menu, food intake had increase (Thornton, 2002).

The food industries that are producing texture modified foods are very aware of the need for texture modified food that is visually appealing. A wide range of products suitable for people with chewing and swallowing problems is offered. To improve the product range and offer extensive knowledge to the food industry it is important to study all relevant factors.

This literature review, based on publications available today (2004), is about how and with which ingredients it is possible to produce palatable food for elderly suffering from Dysphagia. The report describes the elderly and their food consumption. This includes the influence of ageing on taste, the demands of the elderly and definition of Dysphagia as well as an overview of the present knowledge about preparation of modified food. Common taste, flavour and texture modifiers like fat and egg are discussed whereas great importance was attached to commonly thickener used in the Dysphagia diet and their influence in sensory perception. With sensory tests it is possible to obtain important information of why food tastes good or not. Two parts of sensory evaluation are described, consumer tests and analytical tests, including Time intensity studies. Finally, a carrot system and a meat system are discussed.

Characteristics, processing methods and interactions between the ingredients of these foods are described as well as elderly opinions.

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2. Elderly and Food Consumption

The proportion of the population over the age of 60 increases and will be over 25% in Europe within the next 25 years. This group is a growing market with special demands and interests (Bengtzon, 2003; Filion and Kilcast, 2001). In 2050 the group of people over 64 years will represent 23% of the Swedish population (SCB, 2004). With getting older, many people suffer from decreasing physiological functions, such as dental and muscular dysfunctions, slower gastric empty, deteriorated function of senses which result in a lower interest in food-related activities and also altered ability to process foods in the mouth. This often leads to an inadequate dietary pattern (Huttenbauer, 2004; Roininen et al., 2003a; Drewnowski and Shultz 2001; Schiffmann, 1998). Drewnowski and Shultz (2001) found lower intake of calcium, iron, zinc, B vitamins and vitamin E which increase the risk of diet-related illness. Further they found that the older people consume too little fruits and vegetables. The recommendations for vegetables consumption were met by less than one in three elderly and less than half met the recommendations for fruit.

2.1 The influence of ageing on taste and smell

Normal parts in the ageing process of some people are diminished taste and smell abilities. The taste threshold increases due to a reduced number of taste receptors and changes in taste cell membranes (Ng et al., 2004; Ohr, 2000). Bengtzon (2003) found decreased taste perception in the elderly. Age group differences in optimum concentrations have been investigated in several studies, with varying results. Mojet et al. (2001) studied gender differences in elderly. Older women tended to be more sensitive for sucrose and acetic acid than older men. They also found differences between elderly and young. Threshold increases most for the salty and the umami taste. Ng et al. (2004) reported, that elderly preferring high salt concentration and high sucrose concentration. There is an increased preference for bitter vegetable because of reduced perception of bitter taste (Drewnowski and Shultz, 2001).

Taste can also be influenced by different commonly drugs (Ng et al., 2004; Mojet et al., 2001). A reduced perception in tasting often results in dissatisfaction with food, diminished appetite and lost motivation to eat (Ng et al., 2004; Donini et al., 2003; Ohr, 2000).

Losses in olfactory sensitivity tend to be relatively uniform, affecting responses to all or most odour stimuli (Cowart, 1989). Stevens et al (1984) came to the conclusion that the sense of smell seems to decline more with age than the sense of taste. Studies have shown that more than half of people aged 60-80 had a major olfactory impairment, while three-quarters showed olfactory impairment after the age of 80 (Doty, 1989). Impaired food identification by the elderly appears to be linked to olfactory deficits, as opposed to basic tastes (Schiffman, 1977). Olfactory dysfunction has been associated with lower interest in food-related activities (e.g. eating out, shopping in specialty food stores, cooking), lower preference for sour/bitter foods and with lower intakes of low-fat dairy products (Duffy et al., 1995). The elderly are often unaware of their sensory loss and note no decrease in their appreciation of foods and their ability to smell (Rolls and Drewnowski, 1996).
2.2 Demands of the elderly

When designing foods for the elderly it is very important to be in line with their requirements. Nutritional requirements should be reached with nutrient-dense food that give adequate energy and nutrient intakes (Filion and Kilcast, 2001; Ohr, 2000). Reduced perception in tasting and smelling and demands for special designed and high tasty foods should be respected (Bengtzon, 2003; Ohr, 2000). Flavour enhancers and specific food flavours can help to reobtain lost appetite and hunger, and also increase the enjoyment of food (Ng et al., 2004; Mathey et al., 2001; de Graaf et al., 1994). Mathey et al. (2001) found increased dietary intake and body weight when flavour-enhanced cooked meals were served. Meal should contain components that correspond to the habits of elderly (Rousset and Jolivet, 2002). Elderly are receptive for functional foods, but the food should also be traditional and one has to consider its cultural and emotional values (Donini et al., 2003; Ohr, 2000). Elderly prefer convenience food possible to prepare for one or two persons and sold in individual packages. Due to motor deficits the packaging should be easy to open. Eldery with vision disorders demand for large prints (Filion and Kilcast, 2001; Ohr, 2000). Many elderly are unable to consume food in its conventional form because of chewing and swallowing problems (Huttenbauer, Patent, 2004).

2.3 Swallow and Dysphagia

Swallowing is an important body function which is essential for health (Raut et al., 2001). The first step when eating is chewing and mixing with saliva (Bender and Bender, 2000). After mastication and mechanical and chemical stimulations of the pharyngeal and laryngeal mucosa the food can be swallowed (Kajii et al., 2002). The symptom of suffering from difficulties in the swallowing process is called Dysphagia. Patients complain about difficulties in chewing, swallowing, speaking and Xerostomia (dry, burning mouth). It often occurs in neurological or mechanical dysfunctions affecting the head, throat and oesophagus that the food can not be consumed in its conventional form (Huttenbauer, Patent, 2004; Pace et al., 2002). There are a lot of several causes reported. Throat dryness related to a progressive atrophy of the salivary glands is often a result of radiation therapy for head and neck malignancies, lack of nutrients such as zinc, drug use and/or autoimmune diseases (Donini et al., 2003; Dusek et al., 1996).

Drinking while eating, cutting food into smaller portions and avoiding certain foods are common changes in behaviour of Dysphagia patients (Dusek et al., 1996). Thickened liquids of puree consistency are often recommended (Raut et al., 2001).

2.4 Preparation of food for Dysphagic persons

Processed and formed conventional solid food can be consumed by individuals suffering from chewing and swallowing difficulties. The desired texture should be easy to swallow but not have too low viscosity as causing aspiration. When passing the mouth and throat, the portion should be staying together. To increase the
enjoyment of food and the acceptance and to prevent unsavoury shape the product should retain the aesthetic and sensory characteristics of the delivered food. Pureed food looks often unappetizing and can be lumpy and/or runny. Pace et al. (2002) found that visually appealing food helps patients to enjoy their meals and further that intake increases.

Any type of conventional food can be prepared to better fit persons suffering from Dysphagia. The first step is the reduction of the particle size to a size of about 2mm because ingestion without mastication should be possible. It is important to make sure that the comminuted food is free of all chunks greater than about 2mm by controlling and sieving out. Then the food is thickened with any lubricant or thickener, depending of the food material. Foods containing more water need more thickener. After adding flavours, seasons and supplements the food might be transferred into a shape that mimics the original food and then packed after freezing or pasteurisation. The food is heated before serving (Huttenbauer, Patent, 2004; Moditex Food Ltd., Bulmer, Patent, 2003).
3. Taste, Flavour and Texture

3.1 Perception of taste, flavour and texture

Flavour is one of the key determinants of the palatability of food (Donini et al., 2003) and means the overall impression of aroma, taste, texture and mouthfeel. If food is chewed, the structure of the matrix changes and flavour compounds interact with olfactory receptors in the nose (odour/aroma) and with lingual receptors in the mouth (taste). This influences the quality, quantity, stability and the ultimate perception of flavour in food. To perceive flavour certain thresholds must be reached (Harrison, 1998; Klahorst, 1997; Taylor, 1996).

In the mouth, taste components are generally transported to the taste receptor cells by the saliva or food fluids (Miller, 1995). Five separate tastes can be distinguished: sweet, salt, sour, bitter and savoury (umami). The different tastes have different transduction mechanisms (Bender and Bender, 2000). The release behaviour depends on the physicochemical properties and the food matrix (van Ruth et al., 2002). An adequate volume and composition of saliva is important for both taste and aroma release (van Ruth et al., 2001).

In the nose a smell sensation is the binding of substances having odour properties. The sense of smell in man results from stimulation of chemoreceptors of the olfactory, trigeminal, and possibly terminal nerves (Lovell et al., 1982).

Odorants are released from the food during mastication and are transported retronasal to the nasal cavity where they interact with the olfactory receptor cells. After transforming of the sensory information the electrical signals are transported to the brain (Laing and Jinks, 1996).

The texture of foods is the combination of the perception of vision, hearing, somesthesis and kinesthesis (Wilkinson et al., 2000). Differences in texture result in different chewing time, moistening and sizes of particle after mastication (Hoebler et al., 2000). Texture is important for flavour release and perception. Solid foods that are chewed need longer time than drinks that are consumed almost immediately and spend only seconds in the mouth. The forming of a thin film in the oral cavity is important for flavour perception (Harrison, 1998; Klahorst, 1997).

3.2 Ingredients to modify taste, flavour and texture

3.2.1 Flavour enhancement

Flavour enhancement is addition of flavours to improve food palatability and acceptance. It is not only the traditional method to increase flavour with spices, herbs and salt (Schiffmann, 2000). “Natural flavours” are naturally occurring flavours or formed by heating, ageing or fermentation. Synthesized, naturally occurring flavours are considered “nature-identical” flavours. Flavours that are synthesized but not existing in nature are called “artificial flavours” (Klahorst, 1997).
Flavour enhancement also increases saliva flow which is important for health (Schiffmann, 2000).

MSG, the sodium salt of the amino acid glutamic acid has unique taste qualities. In the Japanese language it is called umami (Schiffmann, 2000). MSG is a common food additive used to enhance flavour (Schiffmann, 2000; Best, 1992). Best (1992) found synergy in mixtures with 5’-nucleotides (inosine-5’-monophosphate (IMP) and guanosine-5’-monophosphate (GMP)).

3.2.2 Fat

Fat is very important to flavour and texture. Most aroma compounds are fully or partly soluble in fat which influences the mouth feel and the intensity of perceived thickness. Fat act as solvent of lipophilic flavour compounds and there by suppress the release of such compounds. Further fat has an ability to depress many off-flavours. (Chung et al., 2003; Wendin, 2001). According to Klahorst (1997) triglycerides in foods can attract flavour compounds, depending on the fatty-acid length and degree of unsaturated compound of the fat. Triglycerides with only unsaturated oleic acid bind more flavour than those with only saturated fatty acids. This is not in line with Roberts et al. (2003) who found no release-differences in lipids with different fatty acid compositions. Further, they found increased flavour release with increased solid fat content. Trius and Sebranek (1996) found that fat in meat products has a great impact on tenderness, juiciness, and overall appearance.

3.2.3 Egg

Eggs offer several functional properties to be used in the food industry. One of the most important processes to improve texture is coagulation during heating. With combining different qualities of egg products (egg white, egg yolk and complete egg) it is possible to get different texture grades. Eggs are also used as emulsifier or foaming agent (Stadelman and Cotterill, 1995; Mine, 1995; Hammershøj and Andersen, 2002).

Further eggs contribute to a high nutritious diet and suits well the increased nutritional requirement of elderly people. Eggs contain nutrients such as folate, riboflavin, selenium, choline, and vitamins B 12, A, K and D. The labile protein pool benefits from the high biological value of egg protein (Herron and Fernandez, 2004). The composition of eggs is shown in Table 1. It is also shown that egg can make a contribution to the nutrition of the elderly.
Table 1: Composition of 100 g "standard" egg comparative RDI to vitamins och minerals (Watson, 2002)

<table>
<thead>
<tr>
<th></th>
<th>Quantity/100 g</th>
<th>RDI(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B₁₂ (µg)</td>
<td>2.50</td>
<td>125</td>
</tr>
<tr>
<td>Biotin (µg)</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>Jod (µg)</td>
<td>53.00</td>
<td>53</td>
</tr>
<tr>
<td>Vitamin D (µg)</td>
<td>1.75</td>
<td>18</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>0.47</td>
<td>39</td>
</tr>
<tr>
<td>Folate (µg)</td>
<td>50.00</td>
<td>17</td>
</tr>
<tr>
<td>Vit A RE (µg)</td>
<td>190.00</td>
<td>21</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>200.00</td>
<td>33</td>
</tr>
<tr>
<td>Vitamin E (mg)</td>
<td>1.11</td>
<td>11</td>
</tr>
</tbody>
</table>

Eggs with content in higher levels of the polyunsaturated fatty acid are called omega 3 eggs. Hens, fed with a special diet of micro alga, fish oil or fish meal produce eggs that are higher in omega 3 fatty-acids. Studies have shown that consumption of omega 3 egg can result in decreased blood pressure and lower blood triglyceride levels. Omega 3 eggs provide a dietary alternative to fish and seafood, where Omega 3 fatty-acids are commonly found (Surai and Sparks, 2001).

Adding Vitamin E to the hens’ diet, the produced eggs can also provide an additional source of this important antioxidant.

Lutein-Enhanced Eggs are from hens fed an enhanced diet containing higher levels of Lutein. Lutein is a carotenoid that has benefits for eye. Its antioxidant mechanism reduces harmful free radicals. Lutein is found in green vegetables such as spinach and broccoli, 6-8 mg of lutein per day is recommended. Most elderly do not get enough lutein in their diets but they can not increase their intake of these vegetables. Lutein enriched eggs are a good alternative and studies have shown, that lutein from egg is more useful than lutein from vegetables (House et al., 2002; Handelman et al., 1999).

3.2.4 Thickeners

Thickeners are used to modify the consistency of foods. Traditionally, starch and gelatine have been used. Today, a wide diversity of hydrocolloids is available, for example gelatine, starch, pectin and carrageen. To add extra calories to a product, starch-based thickeners are used. Thickeners may also act as a fortifier for vitamins, minerals and protein (Pace et al., 2002; Costell et al., 1995; Imeson, 1992). Each thickener produces its own characteristic texture, depending on the base food (Lotong et al., 2003). Kälviäinen et al. (2000) found hardest texture in starch samples, elastic texture in gelatine samples, and fragile texture in pectin samples. Depending on food system and other ingredients, thickeners can also affect flavour perception and release (Kälviäinen et al., 2000) even in low concentrations (Bylaite et al., 2004). Klahorst (1997) found that flavour components bound to different polysaccharides in varying degrees. With constant flavour concentration and increasing level of polysaccharides the perception of aroma and taste decreases. Lotong et al. (2003) found that starch increased bitter, metallic and astringent
properties while the main flavour of the base food was suppressed. Jaime et al. (1993) found significant effects on perceived flavour and aroma by using gelatine, while Wendin et al. (1997) found unaffected perceived intensity of maltol and depressed sourness. With the addition of hydrocolloids Cook et al. (2003) found a reduction in perceived salt, garlic and mushroom flavours and recommend therefore an increased addition of flavouring, salt and fat.

Used in dysphagia diet, thickeners improve the products mouth feel properties, handling, and stability characteristics (Imeson, 1992). The risk of aspiration reduces. Further, pureed food can be presented in food shapes so the food is visually appealing (Pace et al., 2002). With modified consistency, swallowing time may be longer than with liquid consistency, which implies that sensory characteristics might be changed. This might affect acceptability and compliance in patient use (Lotong et al., 2003). Thickeners that have been used in the preparation of foodstuff for Dysphagic patients are: yam flour, rice flour, glucomannan, wheat flour, tapioca, corn starch, pectins, soy flour, natural gums, gelatines, cellulose, inulin, oat fibre, whey, and potato starch, or a mixture of those materials, depending on the food material (Huttenbauer, Patent, 2004). Hormel Food Cooperation, Sheldon (Patent, 2000) used modified food starch to thicken a hydrolyte isotonic beverage because this thickener provided the necessary viscosity. Simply Thick Llc., Holahan (2004) patented improved thickened beverages for Dysphagia patients and preferred the thickener xanthan gum because it is a soluble food fibre and provides therefore few calories to the food. It does not contain gluten which makes it suitable for patients with allergies. Compared to commercially available thickeners, which are based on starch, they found that xanthan gum gave lower calories, higher food fibres, lower carbohydrates, better overall taste and better overall appearance. They claimed that starch-based thickeners provide a milky, cloudy appearance, starchy, metallic taste and do not thick every beverage, for example alcoholic beverages and carbonated beverages. In food thickened with xanthan gum they did not find negative off-flavour but a clear solution. Wendin et al. (1997) found depressed sweetness in xanthan-thickened milk products.

3.2.5 Starch

The polysaccharide starch is present in most parts of plants, for example in leafs, roots, corns and fruit from most green plants. Important sources of commercial production of starch are potatoes, corn, tapioca and wheat.

Starch is based on glucose repeat units. Potato starch contains ca 20% amylose and 80% amylopectin. It consists of a long-chain of glucose residues, amylose is based on linear chains (unbranched), amylopectin is linkaged to branches (branched glucose subunits). Starch is stored in plants in the form of granulates which are extracted during the production process. The thickening effect in water is based upon the absorption and binding abilities of the swelled granulates (Lyckeby Culinar AB, 2003).
4. Sensory test methods

Sensory test methods are divided in two main groups, consumer and analytical test. Consumer tests can be useful to determine the palatability and acceptance of food products in the elderly. The eating quality of all kinds of food can be measured directly by sensory methods.

4.1 Consumer test

Consumer tests are used to explore the consumers’ preferences. Consumers describe their subjective impressions either in qualitative tests e.g. focus group discussing or in quantitative tests where commonly a hedonic scale is used (for example: dislike extremely much – like extremely much) (Lundgren, 1981).

4.2 Analytical test methods

This term comprises two subgroups: Difference tests and descriptive tests. The difference tests are used to identify any difference between two or more samples. Examples of difference test methods are triangle test, paired comparison test and duo-trio-test. The descriptive tests are used to discover the difference between samples and to describe characterises of samples by a trained sensory panel (Lundgren, 1981) and have for example been used to study the effect of thickening agents on sensory qualities, including viscosity and flavour characterises (Lotong et al., 2003).

4.2.1 Time-intensity studies

Time Intensity (TI) studies can be described as an analytical test-method. It is used to study time-related aspects in the flavour perception of foods and beverages, the duration or intensity of perception of a particular factor is measured. The result of a time-intensity study is a curve which generally increases to a maximum level and then in proportion to decreased perceived intensity the curve declines until it reach zeros (Wendin, 2001).
5. Vegetable System

5.1 Carrots

Carrots are cultivated all over the world. In the EU the production increases 2,7% every year. Carrots are storable which implies that fresh carrots are available all the year round. Carrots are commonly used in several products, including frozen foods, tinned food, juice and baby food. Fifty percent of the carrots are consumed raw, consumers like particularly the sweet taste and the content of essential oils (Schaller et al., 1998).

5.1.1 Composition

An important constituent in carrots are carotenes which are precursors of fat-soluble vitamin A. The overall composition of carrots is shown in Table 2.

Table 2: Composition of 100g edible portion (Livsmedelstabell, Livsmedelsverket, 2001)

<table>
<thead>
<tr>
<th>Water (%)</th>
<th>Energy (excl. fibre)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Carbohydrates (g)</th>
<th>Vitamin A (μg)</th>
<th>Vitamin C (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>167 KJ/40 kcal</td>
<td>0,6</td>
<td>0,2</td>
<td>8,7</td>
<td>6800</td>
<td>6</td>
</tr>
</tbody>
</table>

5.1.2 Processing carrots

The main quality characteristics of raw carrots are shape, colour and texture. Size and texture depend on the desired product. Bright orange stands for best quality and high content in vitamin A. A bland, sweet flavour is desired (Smith et al., 1997). A major problem for vegetable processors is the bitter off-taste of carrots. This is also often the reason for consumers’ rejection. After removing the peel and sorting out green and dark parts the bitter taste can be reduced. Further the cultivars are important because some produce more bitter compounds than other (Czepa and Hofmann, 2004). Schaller et al. (1998) found correlation between taste and nitrogen fertilization. Nitrogen fertilization influences the amount and composition of essential oil. Carrots with lower nitrogen application contain more essential oils and more sugar. The taste is more intensive, fruitier, sweeter and less bitter. Mechanical stress after harvest effects higher content of isocumarin, which is responsible for bitter taste, and lower levels of sugar (Seljåsen et al., 2001). Another undesired off-taste is called “fusel oil” (Smith et al., 1997). Talcott et al. (2000) found improved overall quality with reduced heating steps, such as phenolic acid concentration, oxidation compounds and puree colour. Further they studied processing carrots without the removal of periderm tissue, because in the periderm are numerous phenolic compounds located. Deaeration treatments to reduce volatile terpenoids before heating can be a possibility to reduce undesirable flavours associated with periderm tissue. Another undesired sensory characterise is “harshness”, which is also a reason of decreased desirable taste and flavour of carrots (Seljåsen et al., 2001).

In fruit and vegetables potato starch is traditional used to gain clear and transparent appearance, for example in cream/gel and jam. The common used starches are
hydroxypropyl starch E1442 and acetyl starch E1414. The average of hydroxypropyl starch is a higher viscosity after freezing/defrost that less starch is needed (Lyckeby Culinär AB, 2003).

5.2. Carrot Products

Various processing methods have been developed for different products. To preserve carrots, dehydration is one of the commonly used methods. Suman and Krishna Kumari (2002) found consumer acceptance in products made of dehydrated carrots. Further, they found good shelf life and utilisation during emergency periods and off-seasons in these products. Further, carrot powder has many application areas and enriches food with beta-carotene. Islam et al. (2003) found that heat can destroy carotene in carrot and alters texture and colour. A combination of long-time hydrostatic pressure and moderate heat could be a better processing method for carrot. This is in line with Sila et al. (2004) who found improved texture of carrots during thermal processing after high-pressure pre-treatments. De Belie et al. (2002) found that cooking time was the major factor for sensory attributes sweet odour, sweet taste, juiciness, hardness and crispness. It was shown that cooking for up to 15 min decreased the intensity of these attributes.

5.2.1 Carrot Juice

Carrot juice is a relatively good source of beta-carotene. Consumers like carrot juice because of its convenience, colour, aromatic compounds and refreshing characteristics (Chinprahast et al., 2002; Zadernowski et al., 1997; Sims et al., 1993). Conventional manufacturing process of carrot juice includes first heating or blanching then juice extraction. Heating is important to deactivation of pectinesterase activity and colour stability. Highest juice colour and stability was achieved by heating whole carrots, milling, acidifying to pH 5 or 4, enzyme treatment, and pressing (Sims et al., 1993). Cloud particle coagulation is undesired and can be avoided by acidification of the coarse mash prior to juice extraction. Pasteurization could not prevent cloud coagulation (Reiter et al., 2003). Yegudayev (2002) patented a natural carrot juice thickened with vegetable thickening agents, for example guar gum. Vegetable thickening agents are rich in fibres which contribute to the nutritional value. Chinprahast et al. (2002) developed a jelly high fibre drink. They mixed carrot juice and pineapple juice in the ratio 3:7 and added 20% pumpkin puree. More ingredients were sugar, carrageen and sodium benzoate. Pectin helped to form and strengthen the gel structure and resulted in a better attainment of liquid. Zadernowski et al. (1997) found high viscosity in carrot juice added with apple puree. Taste impression and nutrition value were influenced by dry ingredients, such as sugars, pectins and fibres. Luth and Gancendo-Lorenzo (1991) found that heating temperature mainly influenced the consistency of tomato juice.

5.2.2 Carrot Puree

Downey (2002) found reduced drip losses in fresh and thawed carrot purees manufactured with guar, xanthan, carrageen and pectin, while pectin being least effective.
5.3 Elderly opinions on vegetables

Roininen et al. (2003b) found that older subjects value the textural attributes in vegetables, but also the preparation time was important. Elderly rated hard root vegetables as troublesome-to-eat. Undesired characteristics were hard, fibrous, adhere to teeth and contained peel. A required preparation was also perceived as troublesome. As easy-to-eat were perceived vegetables that were crispy, juicy, softy (because easy to bite into) and easy to chew and swallow, furthermore such that needed no or little preparation time. Textures that were perceived as too easy to chew and swallow were not liked. Dysphagia patients avoid eating fresh carrots because they are perceived as difficult to chew (Dusek et al., 1996).
6. Meat System

6.1 Processing Meat

Meat is a complex system of components, such as muscle tissue, connective tissue, fat, and water. Numerous interactions occur among these components, which are responsible for the functional properties of the meat system (Trius and Sebranek, 1996). Meat products are an important protein-source in the diet (Rousset and Jolivet, 2000). In the production of minced-meat products also non-meat products are important. Soy protein, egg, cereal flours, starch, fat and fat replacers play a significant role in the modification of functional properties such as emulsification, water and fat binding capacities and textural properties (Singh-Gujral et al., 2002). Trius and Sebranek (1996) found that carrageen can be used as texture modifier because of its ability to retain water and contribute to gel formation in meat systems. Further, they provide dietary fibre to the product. Nitsch (2003) tested carrot fibre as a water binding agent in the canning of meat products. In ready-to-eat meals and convenience products based on minced meat the carrot fibre can be used up to 3% for reducing jelly separation without a decrease of the sensory quality. Frisco-Findus AG, Hannson (1993) patented a preparation system of frozen meals containing meat and used thickening agents that break down during freezing and reheating for consumption such as gums, starch or gelatine. Shehata et al. (1994) used agar agar gels for thickening canned corned beef and got extremely solid and strong texture and white waxy colour. They also tested apple pectin gel and concluded that it can not be recommended because of its apple flavour. When using carrageen the desired firmness could not be reached. They found that gelatine and vidogum L 175 (1 part kappa carrageen plus 1 part of locust bean gum) and SP 175 (1 part kappa carageen plus 1 part tarakernmehl), produced by Uni-Pectin, Switzerland, gave firm, stable gels.

Huttenbauer (2004) patented a method of making formed food puree products and gave an example using beef. He used a thickening mixture (4% of the beef) of glucomannan and modified starch and a spice package comprised of thyme, salt, pepper, garlic powder, cocoa, onion powder and caramel powder. The particle size of the beef mix is reduced to about 0.6mm in diameter.

Starch is used in meat products to bind water, increase juiciness, contributes the texture and support process. During the denaturising process of meat water is released. Starch contributes to bind this water. It is important to use starch in adaptation of temperature. The properties of potato starch suit well with meat products. At 50°C while the denaturising process of meat begins, potato starch starts to react and binds water. The swelling maximum of potato starch is reached at 70°C, a normal used heating temperature of meat products. Other starches have different swelling properties and are not useful in meat products (Lyckeby Culinar AB, 2003).

6.2 Beef

Beef flavour is very complex and it contains more than 600 carbonyl-, heterocyclic-, sulphur- and nitrogen containing compounds (Wettasinghe et al., 2001).
6.3 Warmed over flavour

WOF is the term to describe the off-flavour of heated again meat which is often perceived as bitter or metallic. The cause is the oxidation of unsaturated fatty acids from disrupted muscle tissue cell membranes. Because WOF is disliked by the consumers the meat industry should be aware of this problem (Bryhni et al., 2003).

6.4 Elderly opinion on meat

Rousset and Jolivet (2000) studied the favourite prepared meat dish of French elderly. Thirty-nine percent stated beef (beef steak, rib steak, beef rib, roast beef). In beef, they found higher stated expected acceptability during an interview than taste acceptability after tasting. Compared to other food products, it was not as tender as expected. Bryhni et al. (2003) found a higher preference for pork in the older people and males. The highest consumption frequency of pork in Scandinavia was found in Sweden and Danmark, people there reported to eat pork 1-3 times a week.
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