Effect of Different Cooking Methods and Binding Materials on Proximate Composition, Physicochemical and Sensory Quality of Different Emulsion Based Chicken Products

Kiran, M.1*, Vinayanada, C.O.1, Jagannatha Rao, B.1, Ravindra, B.D.2 and Ramachandra, B.S.2

1Department of Livestock Products Technology, Veterinary College, Bidar, Karnataka Veterinary Animal Fisheries Science University, Karnataka, INDIA
2Department of Animal Nutrition, Veterinary College, Bidar, Karnataka Veterinary Animal Fisheries Science University, Karnataka, INDIA

*Corresponding author: Kiran M.; Email: kiranm.321@rediffmail.com

Received: 22 Nov., 2017 Revised: 01 Jan., 2018 Accepted: 13 Jan., 2018

ABSTRACT

The meat industry is focused on the development of new products with better nutritional properties and acceptable sensory quality by adopting innovative processing and cooking procedures. In this study, the effects of different cooking treatments (moist cooking, dry cooking and deep fat frying) and incorporation of binders (Rice- *Oryza sativa* and Ragi-*Eleusine coracana*) on poultry meat were investigated. The proximate composition, physicochemical and sensory acceptance (Colour, flavour, Texture, juiciness and overall acceptability) of the meat cooked using the different treatments were compared. The study revealed that moisture and fat differ significantly (p<0.05) among the different cooking methods. However no significant (p>0.05) changes observed for protein and ash. The pH of cooked products varies significantly (p<0.05) and pH was found to be lower in deep fat fried products. The cooking yield of deep fat fried product was significantly (p<0.05) lower than the dry and moist cooked products. There was no significant (P>0.05) difference in sensory ratings between emulsion based product prepared with different binders and also there was no significant (P>0.05) difference among the different cooking methods. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. The incorporation of rice and ragi as binder increased cooking yield and also gave better sensory ratings. Further, there was no significant (P>0.05) difference in physicochemical quality, proximate composition and sensory rating. Ragi which is known to be rich in iron can be effectively used in place of rice as binder in emulsion based chicken products.

Keywords: deep fat frying, dry cooking, moist cooking, ragi, rice

In recent years, the development of the global poultry meat market has been marked by rapid, unexpected and complex changes. This huge global demand of poultry meat is attributed to relatively low and competitive pricing in contrast to other meat, absence of religious taboo with high dietary and nutritional quality. Globally, poultry meat industry is one of the most competitive sector and is currently in its mature stage of development. Rapid urbanization, industrialization and changing lifestyle are driving meat industry to develop various meat products wherein, comminution/mincing offers a profitable solution with efficient utilization of meat and by-products (Verma *et al.*, 2012). Increased global competition coupled with changes in consumer demand is causing an unprecedented spur in processing and ingredients used within the meat manufacturing sector. Finely comminuted meat products/emulsion based products are a mixture of proteins, fat particles, water, salt and often carbohydrates. Heat treatment during different cooking can lead to undesirable modification of meat quality, such as the loss of nutritive value, mainly due to lipid oxidation, and changes in some components of the protein fraction (Rodriguez- Estrada *et al.*, 1997). Consumers demand healthier meat products incorporating health benefitting additives while processing...
while expecting these novel meat products added with healthy additive without compromise on sensory quality.

Cereal flours are one of the commonly used ingredients in preparation of meat emulsion, starch present in the cereals is versatile and economical and has many uses as a thickener, water binder, emulsion stabilizer and gelling agent and used in the production of different meat products. Starch is often used as an inherent natural ingredient, but it is also added for its functionality. However, plenty of cereals are easily available in the market, but selection of the flour should be appropriate that it should not diminish rheological, structural, nutritional properties of the processed meat products. Finger millet (*Eleusine coracana*) is one of the ancient cereal crop used extremely in South Asia, especially in India, where it is generally called “Ragi”. It is a low-cost gluten-free cereal and is a rich source of calcium, iron and phosphorous. It contains a good balance of amino acids (Tripathi *et al*., 2012). Finger millets are known to release sugar slowly in the blood and also diminish the glucose absorption making it millet of choice among health conscious consumers. Researchers have opined that finger millet possess many health benefits like antioxidant, antibacterial/antifungal activity, aldose reductase inhibition, nephro-protective, cholesterol and blood glucose lowering and anti-ulcerative properties (Veenashri and Muralikrishna, 2011; Varsha *et al*., 2009; Chethan *et al*., 2008; Shobana *et al*., 2010).

Meat cooking is one of the critical step in meat processing influencing organoleptic properties, microbial load, shelf life, digestibility and nutritive value boosting consumer acceptance. Meat eating quality can be defined in terms of the sensory attributes like tenderness, juiciness, and flavour. Types of cooking method affect the sensory properties of meat and meat products (Ashok *et al*., 2016). Cooking loss is dependent on mass transfer process during heat treatment hence different cooking methodologies will have different cooking yields (Cheng and Sun, 2008). A high cooking loss gives an expectation of a less optimal eating quality. Weight loss during cooking is an economical issue, because it directly influences quality and economic benefits. Generally, cooking loss/yield is affected by pH, cooking temperature and end point temperature, (Pearson and Dutson, 1994).

To our knowledge, there are very scant studies describing the effect of different cooking methods incorporated with different binders on emulsion based poultry meat products. Hence, this study was conducted to assess the influence of three different cooking methods (moist cooking, dry cooking and deep-fat frying) on proximate composition, physico-chemical qualities and sensory acceptance of emulsion based products.

**MATERIALS AND METHODS**

**Preparation of meat emulsion**

Freshly slaughtered poultry carcasses were obtained from local Slaughter house of Bidar, India. The basic formula of chicken emulsion are (per cent basis (w/w)): chicken meat at 62, chicken fat at 10, rice flour at 10 which is replaced by Ragi in other treatment, salt at 2, sodium tri polyphosphate at 0.05, sodium nitrite at 0.015, sodium ascorbate at 0.5, sugar at 1, ice flakes at 8, spice mixture at 2 and condiment mixture at 5. The dressed chicken was minced using a 4 mm sieve by a meat mincer. The minced meat is known to release sugar slowly in the blood and also diminish the glucose absorption making it millet of choice among health conscious consumers. Researchers have opined that finger millet possess many health benefits like antioxidant, antibacterial/antifungal activity, aldose reductase inhibition, nephro-protective, cholesterol and blood glucose lowering and anti-ulcerative properties (Veenashri and Muralikrishna, 2011; Varsha *et al*., 2009; Chethan *et al*., 2008; Shobana *et al*., 2010).

Meat cooking is one of the critical step in meat processing influencing organoleptic properties, microbial load, shelf life, digestibility and nutritive value boosting consumer acceptance. Meat eating quality can be defined in terms of the sensory attributes like tenderness, juiciness, and flavour. Types of cooking method affect the sensory properties of meat and meat products (Ashok *et al*., 2016). Cooking loss is dependent on mass transfer process during heat treatment hence different cooking methodologies will have different cooking yields (Cheng and Sun, 2008). A high cooking loss gives an expectation of a less optimal eating quality. Weight loss during cooking is an economical issue, because it directly influences quality and economic benefits. Generally, cooking loss/yield is affected by pH, cooking temperature and end point temperature, (Pearson and Dutson, 1994).

To our knowledge, there are very scant studies describing the effect of different cooking methods incorporated with different binders on emulsion based poultry meat products. Hence, this study was conducted to assess the influence of three different cooking methods (moist cooking, dry cooking and deep-fat frying) on proximate composition, physico-chemical qualities and sensory acceptance of emulsion based products.

**MATERIALS AND METHODS**

**Preparation of meat emulsion**

Freshly slaughtered poultry carcasses were obtained from local Slaughter house of Bidar, India. The basic formula of chicken emulsion are (per cent basis (w/w)): chicken meat at 62, chicken fat at 10, rice flour at 10 which is replaced by Ragi in other treatment, salt at 2, sodium tri polyphosphate at 0.05, sodium nitrite at 0.015, sodium ascorbate at 0.5, sugar at 1, ice flakes at 8, spice mixture at 2 and condiment mixture at 5. The dressed chicken was minced using a 4 mm sieve by a meat mincer. The minced meat was placed in a bowl chopper (Maschinenfabrik Dornhan®, MTK 661, Germany) and various additives *i.e* salt, sodium tripolyphosphates, sodium nitrite, sodium ascorbate and sugar were added and mixed thoroughly and chopped further for 1 minute. Then rice/ragi flour, spice mix, ice flakes and onion garlic paste were added and chopped again for 1-2 minutes until a good emulsion was formed. The emulsion prepared was subjected to different cooking treatments as below.

**Moist Cooking (Nuggets)**

Meat emulsion was placed in aluminum moulds, packed compactly and covered. The emulsion filled moulds were steam cooked for 30 min to achieve an internal temperature of about 85 °C. The meat blocks were cooled at room temperature and cut into nuggets of desired size (Naveena *et al*., 2011).

**Dry Cooking (Patties)**

To produce patties 75 mm in diameter and 15 mm in thickness, 70–75 g of the ground meat emulsion was moulded and placed in stainless steel plates pre-smeared with refined edible oil to avoid sticking and cooked in a preheated hot air oven at 175±2°C. The meat blocks were cooled at room temperature and cut into nuggets of desired size (Naveena *et al*., 2011).
turned upside down and cooked for another 5 min for adequate doneness and to improve the appearance and colour. The endpoint core temperatures ranged between 80 and 83°C (Naveena et al., 2011).

**Deep-fat frying (croquettes)**

The small portion of emulsion mix was made in the form of small balls of about 5 g were fried in pre heated sunflower oil maintained at 180 °C for 3-4 min until core temperature of croquette reaches 80 °C. After frying, samples were allowed to drain for a short time before being blotted gently with dry tissue paper to remove excess oil on the surface (Naveena et al., 2011).

**Analytical procedures**

The samples were analysed for the proximate composition, following AOAC procedures (AOAC, 1980). Moisture content was determined by the oven drying method (AOAC 950.46). Total Kjeldhal method (AOAC, 928.08) and Soxhlet method (AOAC, 991.36) were used to determine protein content and lipid contents respectively, and total ash content was determined by using muffle furnace (AOAC, 920.153). The pH of raw and cooked meat samples were determined by homogenizing 10 g of sample with 50 mL distilled water and pH of suspension was recorded by immersing the combined glass electrode of digital pH meter. The weights of samples were recorded before (raw weight) and after cooking. Cooked weight was divided by raw weight and the result was multiplied by 100 to get percent cooking yield. The TBA value of raw and cooked product were determined by using the extraction method described by Witte et al. (1970) with slight modifications. Four-gram sample was homogenized with 20% trichloroacetic acid solution (20 mL) and the slurry was centrifuged (Eppendorf, Centrifuge 5430R, Germany) at 3,000 g for 10 min. Two milliliters of supernatant was mixed with equal volume of freshly prepared 0.1% Thiobarbituric acid (TBA) in glass test tubes and heated in water bath at 100 °C for 30 min followed by cooling under tap water. The absorbance of the mixture was measured at 532 nm using UV-VIS spectrophotometer (Agilent Technologies, Cary 60 UV-Vis, Malaysia) and the TBA values were calculated using a TBA standard curve and expressed in mg MDA/kg.

**Sensory evaluation**

Samples were evaluated for changes in sensory attributes (appearance, flavor, texture, juiciness, and overall acceptability) by about ten semi experienced faculty panel of the Veterinary College, Bidar. The attributes were evaluated using an 8-point descriptive scale (Keeton, 1983) where 8 denoted extremely desirable and 1 denoted extremely poor.

**Statistical analysis**

The overall experiment was replicated on three separate occasions and the data generated for different quality characteristics were compiled and analyzed. The data were subjected to analysis of variance, (two way analysis of variance), least significant difference, paired t-test (Snedecor and Cochran, 1994) and Duncan’s multiple range test using SPSS (SPSS version 13.0 for windows; SPSS Inc., Chicago, IL) for comparing the means to find significant (P < 0.05) differences between binders used, cooking method applied and their interactions for the parameters under study.

**RESULTS AND DISCUSSION**

Cooking is one of the most important factors that affect the quality of meat product due to a series of chemical and physical reactions, as cooking produces certain texture and flavour compounds affecting physico-chemical traits and sensory acceptability of meat products. The results of proximate composition analysis (moisture, fat, protein and ash) and changes in physico-chemical parameters like pH, TBARS and cooking yield of chicken meat incorporated with different binders (Rice and Ragi) as affected by different cooking (moist cooking, dry cooking and deep fat frying) are summarized in Table 1.

The cooking treatment significantly modified the proximate composition of samples, while binding material had no effect on the proximate composition. Cooking methods influences the nutritive values of meat. A cooking method that produces a high-quality meat products having favourable texture and taste are generally chosen by consumers (King and Whyte, 2006) and this cooking has an important effect on the nutritional properties (Kondjoyan et al., 2014). Heat treatment during cooking can cause nutritive value loss. Statistically significant
differences in the moisture content were observed between the studied cooking treatments. Highest moisture content was seen with moist cooking with least moisture in deep fat frying. This lowest moisture content in deep fat frying might be due to heat and mass transfer of oil and air promoting moisture loss. Total lipid was highest during deep fat frying might be due to oil absorption during the frying process (Richa et al., 2016). The water evaporation, melting of fats and loss of soluble proteins affects moisture and lipid content during cooking (Barbantia and Pasquini, 2005). The moisture content observed in current study is similar to other researchers in beef patties (Serdaroglu and Ashik, 2005). The moisture content observed in current study is in agreement with previous studies (Serdaroglu, 2006; Thomas et al., 2006; Kumar and Sharma, 2004; Verma et al., 2010, Verma et al., 2012). There was no significant effect of different cooking methods on ash content of all products. The pH was more in raw emulsion in contrast to cooked products. The deep fat fried and moist cooked rice based products had least pH among all samples. There was no significant (P>0.05) variation pH of cooked products incorporated with different binders but Ragi incorporated raw emulsion had significantly (P<0.05) higher pH in contrast to all samples. The observed pH in current study is in agreement with findings of other researchers (Liao et al., 2010; Ashok et al., 2016; Verma et al., 2010). The higher value of pH in Ragi incorporated cooked products is consistent with findings of Siddiqui and Khan (2011).

Moist cooking had highest cooking yield compared with dry cooking and deep-fat frying indicating higher cooking temperature would bring higher cooking loss (Combes et al., 2003) due to higher moisture retention. In dry cooking and deep-fat frying there is loss in form of evaporative and drip losses (Badiani et al., 1998). The lower yield of deep fat fried products was consistent with Juárez et al. (2010) who reported that frying led to the highest moisture loss. However this results disagrees with findings of other works on deep fat fried products (Alfaia et al., 2010; Serrano et al., 2007). The findings of present study were similar to the results of Naveena et al. (2014), who indicated that croquettes had lower water activity than nuggets and patties. The yield of nuggets and patties were contrasted by other reports (Verma et al., 2010; Nisar et al., 2010).

The degree of oxidation in meat and shelf life of meat products are indicated by TBARS value. As per the

---

### Table 1: The variation in proximate composition and physico-chemical changes (Mean±SE) in emulsion based chicken products incorporated with different binders subjected to different cooking methods

<table>
<thead>
<tr>
<th>Binder</th>
<th>Cooking Method</th>
<th>Moisture (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Ash (%)</th>
<th>pH</th>
<th>TBA value</th>
<th>Cooking Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Raw</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>5.68±0.09&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.49±0.02</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Moist Cooking</td>
<td>71.05±0.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.32±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.74±0.12&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.93±0.10&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.34±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.48±0.01</td>
<td>74.62±1.52&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>67.31±0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.71±0.20&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.06±0.08&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.02±0.15&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.45±0.14&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>0.45±0.03</td>
<td>72.94±2.05&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>52.80±0.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.42±0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.97±0.05&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>2.17±0.13&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.29±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.44±0.02</td>
<td>67.46±0.92&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ragi</td>
<td>Raw</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>5.86±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.46±0.04</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Moist cooking</td>
<td>70.38±0.73&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.58±0.17&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.74±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.95±0.16&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.37±0.04&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>0.49±0.03</td>
<td>70.59±1.12&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>67.31±0.25&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.60±0.49&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.40±0.51&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.08±0.05&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.65±0.12&lt;sup&gt;bed&lt;/sup&gt;</td>
<td>0.52±0.01</td>
<td>69.07±1.86&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>53.8±0.55&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.22±0.28&lt;sup&gt;d&lt;/sup&gt;</td>
<td>17.97±0.44&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.20±0.13&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.50±0.07&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>0.47±0.04</td>
<td>67.60±0.72&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean values bearing same superscripts within same row do not differ significantly (P>0.05)
TBARS values of the different samples chicken emulsion subjected to different cooking had same fat and lipid stability. The lowest rate of lipid oxidation was observed in meat which has been subjected to high temperature of cooking (deep fat frying) with all rates of oxidation process were comparable. The lower oxidation as indicated by low TBA value might be combined effect of a relatively high temperature and a shorter cooking time. The TBARS values obtained were similar to those found by Prathyusha et al. (2016), Naveena et al. (2014) in nuggets and patties respectively. Similar results have been noticed by Serrano et al. (2007) who found that cooking method has no effect on TBARS values in restructured meat products.

A sensory profile analysis of meat is a method for description of the eating quality in an objective way. The eating quality attributes of any meat product is a combination of appearance, odour, flavour and texture including tenderness and juiciness. The results of sensory evaluation of emulsion based chicken products shows that different cooking methods had no significant effect on colour, flavour, texture, juiciness and overall acceptability (Table 2). The changes in eating quality attributes with different cooking techniques have been well documented (Dransfield et al., 1985; Heymann et al., 1990; Wood et al., 1995). Though Ragi had black colour which was assumed to hinder acceptance of the product, the sensory scoring ruled out this assumption indicating equal sensory acceptance of ragi incorporated products. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. The higher granular size of ragi crystalline granules confers therapeutic advantage to ragi by slowing down digestion, which is of great help in controlling diabetes and obesity (Mohana et al., 2005).

**CONCLUSION**

The effects of different cooking treatments and incorporation of binders in chicke based emulsion meat products were investigated. There was no significant difference in sensory ratings between emulsion based product prepared with different binders and also there was no significant difference among the different cooking methods. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. Understanding of this changes helps small enterprenuers to fix the price of livestock products. Ragi, which has been demonstrated to be rich source of iron, bio-available calcium, vitamins and other nutraceuticals can be incorporated at 10% level with out affecting sensory acceptance of any emulsion based products. The obtained results warrant a need for follow-up research to investigate in detail all observed significant

### Table 2: The variation in Sensory profile (Mean±SE) in emulsion based chicken products incorporated with different binders subjected to different cooking methods

<table>
<thead>
<tr>
<th>Sensory Profile</th>
<th>Cooking Method</th>
<th>Rice</th>
<th>Ragi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Moist cooking</td>
<td>7.00±0.29</td>
<td>6.70±0.42</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>6.90±0.35</td>
<td>6.80±0.25</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>6.90±0.28</td>
<td>6.40±0.27</td>
</tr>
<tr>
<td>Flavour</td>
<td>Moist cooking</td>
<td>6.83±0.47</td>
<td>7.05±0.30</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>6.85±0.33</td>
<td>6.35±0.35</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>6.65±0.28</td>
<td>6.55±0.35</td>
</tr>
<tr>
<td>Texture</td>
<td>Moist cooking</td>
<td>6.89±0.31</td>
<td>6.50±0.52</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>7.10±0.31</td>
<td>6.60±0.43</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>6.80±0.33</td>
<td>6.50±0.37</td>
</tr>
<tr>
<td>Juiciness</td>
<td>Moist cooking</td>
<td>6.83±0.33</td>
<td>6.85±0.39</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>7.25±0.25</td>
<td>6.95±0.32</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>6.85±0.26</td>
<td>6.85±0.30</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>Moist cooking</td>
<td>7.56±0.24</td>
<td>7.50±0.27</td>
</tr>
<tr>
<td></td>
<td>Dry cooking</td>
<td>7.40±0.22</td>
<td>7.10±0.31</td>
</tr>
<tr>
<td></td>
<td>Deep fat frying</td>
<td>7.30±0.30</td>
<td>6.90±0.31</td>
</tr>
</tbody>
</table>
factors affecting emulsion based chicken products subjected to different cooking process.

ACKNOWLEDGEMENTS
The financial assistance from KVAFSU, Karnataka, India under staff research project (DR/KvaFSU/Staff-Research project/2015-17/Ani sci-12) is acknowledged.

REFERENCES


